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E. J. Mehren, Editor — Charles Whiting Baker, Consulting Editor

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An Aërial Disaster

STRUCTURAL engineering resources provide no reasonable means of protecting city buildings from the impact of a falling airship. Such a disaster as occurred in Chicago three days ago, when the car of a flaming dirigible plunged through the skylight of a downtown bank, will remain one of those rare happenings from which little is to learned toward safeguarding the future. Other great Chicago disasters of recent years—the Iroquois Theater holocaust or the capsizing of the "Eastland"—were at least in minute measure redeemed by the resulting progress toward greater public safety. In the present disaster there is no such redeeming consideration, unless it be the lesson that aërial "joy-riding" must be placed under closer surveillance.

Box-Car Shortage Due

IN A few weeks the movement of the largest wheat crop on record will be under way. No one can say just where the movement will be greatest or where the millions of bushels will be stored, but the grain is here and the Government must buy it. At any rate, for some months all of the box cars that can possibly be found will be directed to the wheat traffic. Those concerned with the purchase or sale of commodities using box cars will do well to note this prospect and arrange their business accordingly. Box cars, like all other railroad equipment, have not increased normally in the past few years. When a congestion of demand meets a reduction in supply there is always trouble.

An Unjust Discrimination

EVER since the United States Public Health Service began publishing its directories of health officials in *Public Health Reports*, it has done an injustice to engineers and other technically trained men serving in the capacity indicated. Great care seems to be taken to put "M. D." after the name of every health officer entitled to it, but the engineers, chemists and bacteriologists in the service receive no credit for similar college degrees. To divide public health officials into two great classes—doctors and all others—is unjust discrimination against a large and growing number of highly trained men.

A Hexagonal Diagram

OCCASIONALLY something "new under the sun" emerges. This seems to be true of the ingenious hexagonal diagram for finding the velocity of water in pipes, contributed from beneath the South American sun by Mr. Anthony, and reproduced on p. 169 of this issue. As an example of the uses to which the diagram may be put Robert E. Horton suggests that it can be used to find "the relative capacity of pipes in accordance with the Barnes formulas, in which different exponents are used for each different class of pipe."

Continue the Engineer Training Camps

MILITARY engineering is not a stationary science. The war has proved that, as it has proved the importance of the fighting engineer. Everything in reason must be done to make the training of our future Army engineers as scientific and as resultful as possible. In doing this, no one thing could be of more value than the continuance of Camp A. A. Humphreys, on the Potomac below Washington, as a training camp both for officers and for troops. Economy in public expenditure is, of course, necessary now that war emergencies have passed, but parsimony is dangerous. Civilian engineers join the Corps of Engineers in its plea to Congress that sufficient funds be provided to continue the temporary construction of the camp, so that engineer soldiers can be trained there in the essentials of their business. In time, let us hope, the camp will be made permanent.

Hindering New York Harbor Development

NEW YORK CITY—or at least the administration which at present governs the city—continues to pursue its dog-in-the-manger policy in the development of New York harbor. Not very long ago it managed to put off for another year consideration of the proposals of the interstate harbor board for joint action by the States of New York and New Jersey. Now, through its Department of Docks, it comes forward with the so-called Hulbert plan of port development, which is nothing more than the continued construction of steamship piers, at first on Staten Island and later at scattered points around the city's 600-mile shore line, disregarding entirely the fact that extra provision for steamships will only further complicate the port problem unless some way is devised to take care of the goods coming from or going to these ships. This failure to recognize the elements of port design and management is not due to ignorance, but to the parochial viewpoint common to the politician. Those in charge of the city simply cannot get themselves to admit that New Jersey has any part whatsoever in the natural harbor at the mouth of the Hudson. Meanwhile, private interests are alive to the necessity which the official mind will not admit. Within the past month three separate schemes for elaborate port terminal construction on the lower New Jersey shore of the inner harbor have come to light. Each one envisages the port as a machine through which must move in two directions a large part of the world's business, and not as a mere landing place for steamships. All of these plans are advanced well along in design and each one has a considerable financial backing. It would be no surprising thing if the City of New York found the control of the harbor deliberately taken by the opposite state because the city officials could not see outside their polling places.

Inland Navigation for Ocean Steamers

THERE are two ways for an inland city to become an ocean port—to bring the ocean to the city or to extend the city to the ocean. Los Angeles has not had conspicuous success in the latter process; Manchester, England, has apparently, at last, proved that the former has some virtue. In this country Houston, Tex., is emulating the British inland port and, as noted on p. 156, is obtaining some measure of that port's success. These two comparatively recent projects serve to illustrate the possibilities of inland navigation for large steamers, although they do not necessarily support arguments in favor of such enterprises in general.

For Houston a 50-mile dredged channel along an existing river and creek and through a landlocked bay sufficed to effect communication with the open sea. For Manchester there was required a 35-mile ship canal across settled country, with heavy excavation, and provided with locks and bridges. Including the channel, docks, warehouses and other facilities, the cost to date at Houston has been about $7,000,000, a large proportion of which was paid by the Federal Government for developing the channel. At Manchester the cost had reached $84,000,000 in 1912 and had been met by a private company in which the city had a large investment. Furthermore, Houston is a shipping rather than a manufacturing center, while Manchester was a great manufacturing and commercial city with extensive foreign commerce, at the time when the ship canal was first proposed. The enterprise shown in carrying out this great British project is illustrated by the recent action of the company in displaying full-page advertisements in American daily papers.

Extension of ocean navigation to cities located on inland waterways is often claimed as an argument for costly development of such waterways, natural and artificial. This argument is not universally applicable, however, owing particularly to the factors of difficulty and loss of time in operating large vessels through restricted channels for considerable distances. Economical operation of ocean vessels, as a general rule, requires that they be kept moving at full speed as far as possible, and that terminal delays be avoided. This former factor is perhaps less important for cargo and irregular or tramp steamers than for regular liners, but, generally speaking, it is more economical to operate ocean vessels between ports which are not far from the seaboard.

Where high cost of development is required to open up an inland waterway with a view to ocean connections, thorough and unbiased study is a necessary preliminary. It is to be remembered, for instance, that for many years the Manchester Ship Canal was far from reaching the financial success that had been predicted. On the other hand, its effect in promoting the growth and prosperity of the city was, it was asserted, well worth the cost, although this argument would not appeal very strongly to those who had made investments with the expectation of good returns. In projects of this class, three important elements for investigation are the length and character of the waterway, the prospective traffic, and, especially, the cost of providing the necessary navigation and terminal facilities. Such matters call for expert service and cannot be disposed of by rhetorical display or visions based upon biased imagination.

Centralization of City Traffic

CITY development questions of large bearing are dealt with in the report on Cleveland rapid transit, abstracted in this issue. The report, curiously enough, is not a rapid-transit report at all, in a sense, and if its recommendations prevail it will postpone rapid transit for a number of years. But beyond this it will bring about a concentration of traffic and business in one central spot of Cleveland, in a degree unlike anything to be seen elsewhere. In both respects the report is out of tune with the general tone of civic and engineering opinion.

The fact that the report is against rapid transit is of interest far beyond the confines of Cleveland. The engineers who make the report state that the city is ripe for rapid transit, on the score of both size and long-haul character of traffic. Nevertheless, they do not recommend that the city undertake the construction of a rapid-transit system now. Nor do they report in express terms against it, though they reach the same end by advising that street-railway improvement be carried out at once. Apparently their reasons against rapid transit are mainly financial; they fear that the revenue would not pay the cost, or that it would be taken from the present traffic income of the street-car system.

These views are likely to be a damper to rapid-transit enterprise in other cities, now struggling toward transit improvement. The public opinion on which all such movements rest is easily impressed by analogies from other cities. Yet conditions are essentially different as between city and city, and it would be both illogical and unfortunate for such cities as Cincinnati, Pittsburgh or Detroit to shape their action under influence from the Cleveland report.

While in its bearing on centralization the report has primarily only local meaning, it is this phase of the matter that is really vital. Together with the Public Square union railway terminal recently proposed, the street-car subway loop system now recommended will inevitably tend to mass all the city's passenger traffic in a small area—virtually in a single point. Should experience show the results to be undesirable, or in the long run perhaps intolerable, the cure for the condition created might easily prove to involve formidable losses, out of comparison with the construction cost now involved.

Already centralization of traffic is an evil in Cleveland. It is brought about by the Public Square system, with return looping of all car lines at the Square, necessitating transfer on any through journey. This unique system results in an unusual downtown congestion, a restriction of the real business district to a very small area, a hampering of vehicle traffic, and a tendency to delay the integration of east and west sides into a unified city. The system is a key element in all traffic and city development problems of Cleveland.

In approving this centralization system the engineers who make the present report take issue with the general view that the cure for terminal congestion in large centers is distribution of traffic. Their proposals will indeed intensify the concentration by increasing the capacity of the Square street-car terminal through adding more loops, and thereby making it possible to mass a larger traffic on the Square. In effect they advise that the downtown terminal system which has been

the basis of growth of the half-million Cleveland be made also the basis on which the future one to two-million city is to develop.

We have previously had occasion to discuss the tendency to endure and even seek concentration of traffic by such devices as union terminals. In discussing the proposed railway terminal on the Public Square of Cleveland, in our issue of Jan. 30, 1919, we protested against deliberate seeking after centralization. In another form, the same tendency is expressed in the street-car terminal now recommended, and we might at present repeat, with merely verbal change, the plea for distribution of traffic that we made six months ago.

It will be interesting indeed to observe the further development of the situation. The problem presented has immediate importance only to Cleveland, but it will carry lessons of value to many other communities.

Developing the Engineering Mind

MOST important among the suggestions at the Baltimore meeting of the Society for the Promotion of Engineering Education were those for the training or development of the "engineering mind." In the abstracts on another page of this issue, C. F. Allen, after thorough investigation, presents the advantages found in the "case system" for the study of law; Major More and Captain Duckering describe the "problem method" applied at the Engineer School, Camp A. A. Humphreys, Virginia, and Dean Anthony discusses radical changes at Tufts College, all with this object in view.

These new developments in engineering education are seen to be fundamentally related to the university idea expressed by F. J. E. Woodbridge as follows: "The idea of the university is the idea of the organized discovery of the mind"; this involves "the discovery that the world, although it is moved by its own forces and according to its own laws, is yet controllable just in proportion as it is understood. By itself it is solid and unyielding; penetrated by the mind it is fluid and convertible. By itself, it is man's master; through his mind, it is his servant."

A clear conception of the distinguishing aspects of modern engineering and of the qualities of the engineering mind would aid materially in the notable attempts of engineers and educators to find a basis of common understanding regarding the kind of graduates desired—through the committees, for example, of Engineering Council and of the Society for the Promotion of Engineering Education. Following the conception of the meaning of modern engineering, it is not difficult to formulate the distinguishing qualities of the engineering mind.

Just as the legal mind is distinguished by trained judgment, as applied to human relations, so the engineering mind is marked primarily by ability to measure things, to analyze forces, to compute desired quantities. This involves two phases of mental activity: (1) Truth seeking, by study or research, to determine the characteristics of nature's materials and powers, and to formulate laws of action of nature's forces; (2) the application of these general facts and laws, by computation, design and investigation.

That capacity for both of these principal activities of the engineering mind may be developed by the methods illustrated in the "case system" and the work of the Engineer School is evidenced from reports of results. They apparently build up real engineering judgment—appraisal of the significance of primary assumptions, ability to estimate results from known data, keen interest in unsolved problems or the disputed points in design, and the desire to attain greater facility in the use of the tools of higher mathematics and of reference books for solving such problems. The students also learn to do by doing, through practice in working out similar problems, producing ability to get things done.

The engineering mind also implies a trained imagination, with capacity to conceive structures, machines, railroads or industrial plants with such accuracy that no difficulties are encountered in making the dream come true. If, as one prominent consulting engineer has said, 90% of engineering activity is imitative, there must be something seriously at fault. Is it possible that the educational methods of the past, with their lecture and text book system, are to blame for that lack of vision and initiative which help to explain the unsatisfactory status of the profession in social life?

Breadth of mind is desirable for the engineer, and should include knowledge of the principles of the fine arts—architecture, music, literature. The fact that most of our educated engineers have obtained at best no more than a mere smattering of these is another weakness which helps to explain the engineer's status. Why are the principles of architecture so generally ignored in engineering curricula? Two such closely interrelated professions should certainly be linked by mutual understanding and knowledge. Are they now so linked? Music and literature are the keys to many delightful associations. The world needs the man who can sing at his work, and music offers fields of enjoyment which at the same time widen the opportunity for acquaintance.

Finally, there must be a place in the engineering mind for business knowledge, and ability to place true valuations on both things and human incentives. Only so can the profession keep step with modern progress. Dean Marston has summed up the advantages and needs of business training for engineers, which were thoroughly discussed at the Washington conference reported in our news pages July 3. Economic science, law of contracts, shop management and industrial organization—the underlying principles of all these elements of present-day engineering—are essential.

In the new attempt to meet the demands for exact knowledge and creative capacity in engineering service, it must be remembered that while breadth of knowledge of fundamental principles is needed, a mere superficial knowledge of many things cannot be accepted in place of that intensive, thorough training which makes a man master of one particular thing. Although such mastery may really come only through self-education and cannot result from a college course, yet formal education should contain sufficient test drill in various lines to help the student find himself—to determine his qualifications and help him select his life specialty.

If, as has been said, the moral test of every advance is whether or not it is constructive, the new movement in engineering education is certainly moral. Nature still, in spite of the conquering advance of man, offers the engineering mind many fields for further exploration—adventures into the unknown promising great reward to creative effort.

Harbor Facilities and Development at Houston, Texas

Ship Channel Converts Inland City Into an Ocean Port—City Provides Wharves, Freight Sheds, Warehouse, Railway Connections and Freight-Handling Machinery—Concrete Structures

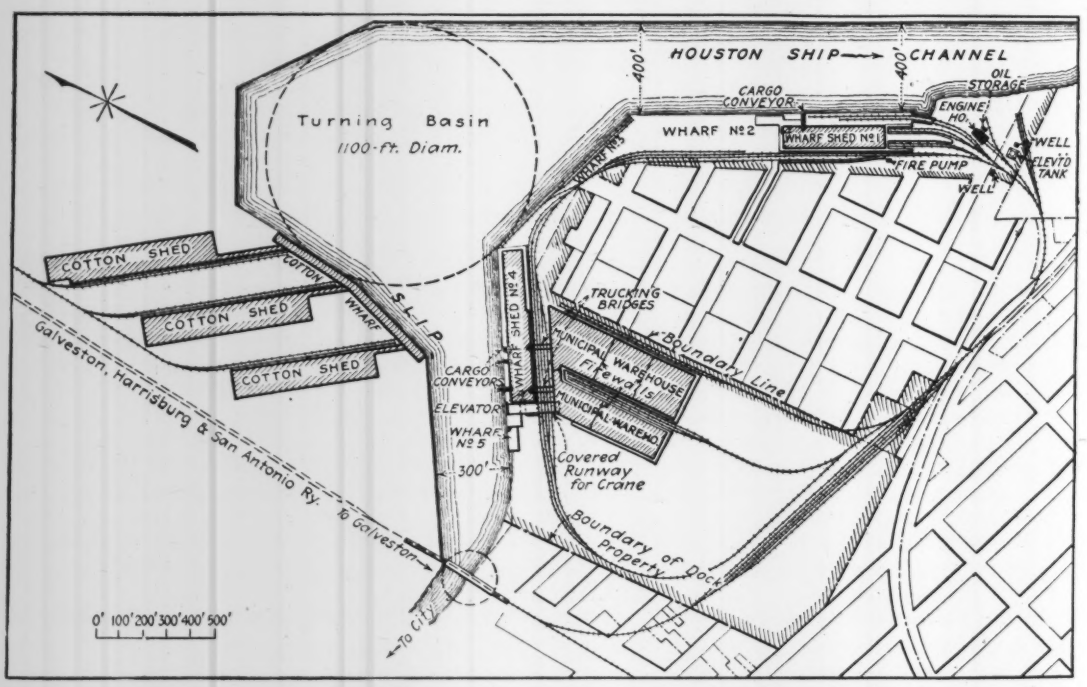
SINCE the establishment of an ocean port at the inland City of Houston, Tex., in 1914, by the completion of a 50-mile ship channel to the Gulf of Mexico, the city has provided wharves, sheds, railway connections and freight-handling equipment to serve the extensive development of shipping trade which is expected when commerce resumes its normal conditions. A description of the project was given in *Engineering News* of May 25, 1916, p. 978. The Houston ship channel extends northwest from the harbor entrance at Galveston across Galveston Bay and through the San Jacinto River and Buffalo Bayon. It terminates in a turning basin, 1100 ft. in diameter, which is about seven miles from the city and is connected by a light draft canal with a wharf at Main St., in the center of the city.

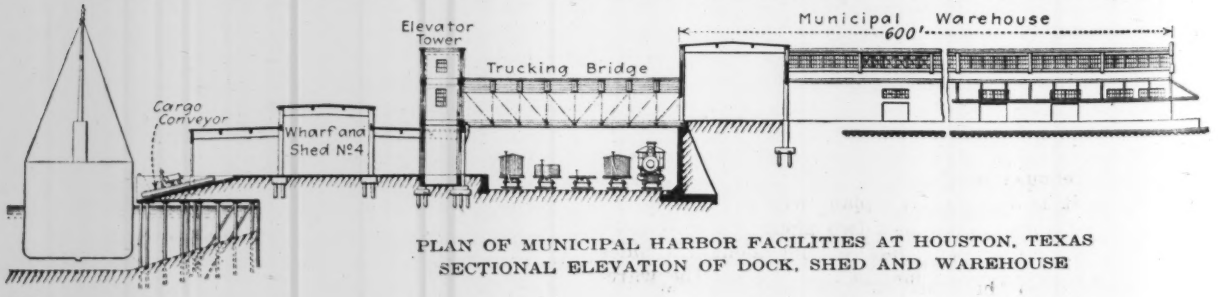
Piers are not used at this port, but wharves aggregating 3730 ft. of water frontage are provided, as shown by the accompanying plan. These include four for general freight, one for cotton and one for barge service. The first freight wharf and the cotton wharf were completed in 1915; the others have been constructed during the period of the war, and some portions were leased by the War Department for use as an aviation supply depot.

Different types of construction are employed. Wharf No. 1 is of creosoted timber and has a timber freight shed which was constructed with open sides, but has since been closed in for use as a warehouse. No trouble has been experienced with the teredo or other boring worms. About 55 ft. back from the face of the wharf is a reinforced-concrete warehouse 100 x 425 ft. This distance from water front proved to be too great, and for later structures it was reduced to 20 feet.

Wharves Nos. 2, 3 and 4 have concrete bulkhead walls of the counterfort type for the water front. That for No. 4, shown in one of the drawings, has a height of 10 ft. and a floor width of 45 ft., with counterforts spaced 15 ft. on centers. Adjacent to No. 4 is the barge wharf, which is of untreated timber throughout, but is so designed as to permit of cutting off the piles and placing a concrete superstructure upon them.

Creosoted timber is used for the cotton wharf, but the cotton sheds behind it are of untreated timber. All buildings are of the one-story type. No sheds are provided on wharves Nos. 2 and 3, and these are unpaved, being used at present for the storage of timber, ties and heavy material. No. 2, however, is designed for the future erection of a two-story freight shed.





PLAN OF MUNICIPAL HARBOR FACILITIES AT HOUSTON, TEXAS
SECTIONAL ELEVATION OF DOCK, SHED AND WAREHOUSE

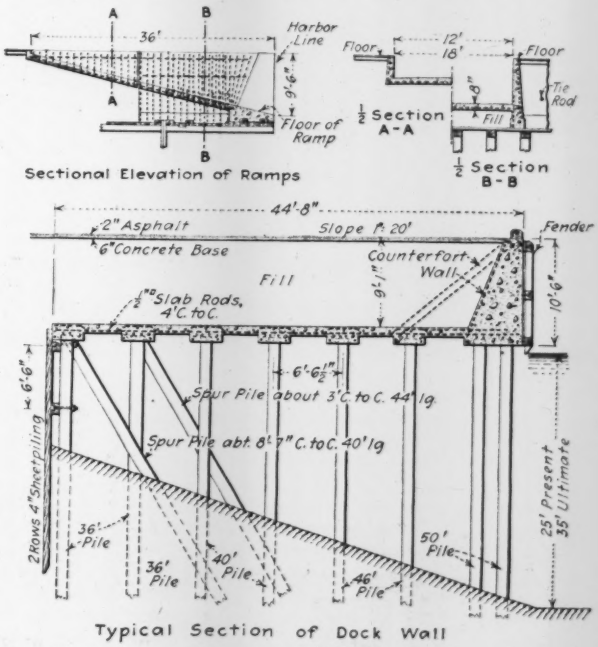
WAREHOUSE
TWO TRUCKING BRIDGES TO ELEVATOR TOWERS
COVERED RUNWAY FOR TRAVELING CRANE
WHARF SHED
30-FT RETAINING WALL CARRIES WAREHOUSE WALL

CRANEWAY AND TRUCKING BRIDGES CONNECT WAREHOUSE AND WHARF SHED

A reinforced-concrete shed 662 x 100 ft. is built on wharf No. 4, with its face 20 ft. from the water front and a 10-ft. platform between its rear side and a group of five railway tracks. Its columns are spaced longitudinally 35 ft. on centers. Two interior rows of columns divide the building into three bays, the middle bay being higher than the others and forming a wide monitor whose sides are fitted with pivoted sash. Triangular footings with three concrete piles to each footing form a rather unusual construction for the interior columns, but the wall columns have four-pile clusters. No piles are used under the front wall, however, as this is on the solid fill supported by the concrete floor of the bulkhead wall. Metal folding doors which move vertically are used for the numerous openings; these are 27 ft. wide in the front wall, 12 ft. in the rear and 20 ft. in the ends.

Temporary storage of inbound and outbound freight awaiting shipment or disposition is provided by the wharf shed. For general storage a municipal warehouse of reinforced concrete has been built on the high ground directly behind wharf No. 4. As this ground was cut away along the water front to the level required for the wharf, a large retaining wall of the counterfort type, 30 ft. high and 20 ft. base, was built along the face of the cut. This supports the end wall of the warehouse. Two trucking bridges extend across the tracks from the floor of the warehouse to the roof of the wharf shed, each being served by an 8-ton elevator in the shed.

This warehouse is about 600 by 400 ft., with only one floor; it is U-shaped in plan, with three railway tracks in the open space and two along the east side. Platforms 10 or 12 ft. wide extend along all sides except the river front. One side or wing of the warehouse has five bays 26 ft. 3 in. between centers of columns and the other has seven bays, the middle bay in each case being higher than the others and forming a monitor for light and ventilation. Longitudinally the columns are spaced 27 ft. on centers. Their footings rest directly on the firm clay soil and they carry a room of the girder-and-beam type, having a 3½-in. slab. The



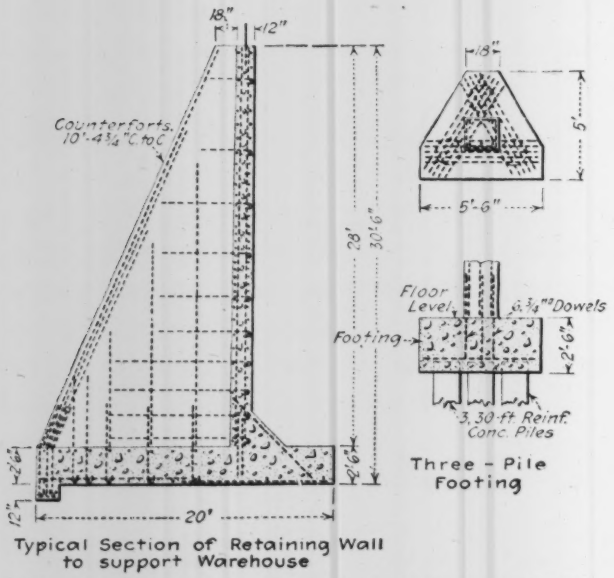
DOCK WALL AND INCLINED RAMP FOR CARGO CONVEYORS

DOCK WALL IS OF COUNTERFORT TYPE

walls are of 9 in. reinforced concrete and similar transverse fire walls divide the interior into five compartments.

One expansion joint across each wing of the warehouse, in the walls and in the roof, provides for a range of temperature from 10° to 120° F. For the walls, the joints are of the mortise type, with ½-in. space packed with tar paper. For the roof, the ends of the longitudinal beams of the sliding section rest on brackets on the adjacent transverse girder of the fixed section; a 2-in. opening in the slab is covered by a semicircular flashing of galvanized iron. Concrete awnings or canopies 10 to 12 ft. wide cover the outside platforms. The 4½-in. slab is built integral with the wall and is stiffened at the outer edge by a rib in which are anchored tie rods or suspension rods attached to the wall above the canopy.

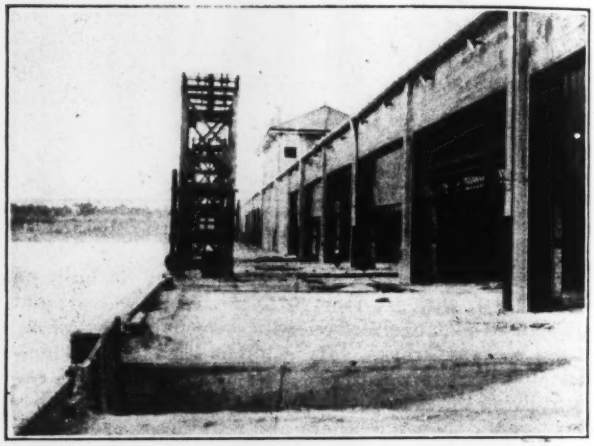
Separate systems of sanitary and storm sewers are provided for the warehouse, the former leading to a septic tank and contact filter bed to avoid pollution of the channel, which has but little current. The flow from the tank passes to two distributing troughs supported on the top of the contact bed, which has about



HIGH RETAINING WALL AND TRIANGULAR FOOTING

4 ft. of crushed stone over 6 in. of coarse screened stone laid upon a bottom course of 4-in. drain tile having ½-in. open joints. The effluent passes out to a cross drain with 12-in. pipe connection to the storm sewer. This plant is designed to handle 4700 gal. of sewage per 24 hours, giving an 18-hour detention period in the tank. A similar plant, differing slightly in arrangement, serves the office toilet in the wharf shed and is located in the fill behind the bulkhead wall. This is designed to handle 1750 gal. of sewage per 24 hours, with the same detention period.

Experiments with different types of floor construction in the sheds were made as follows: Vertical fiber brick paving with asphalt filler on 6-in. concrete base was used in the old shed on wharf No. 1. Some slight settlement has occurred in the portion laid on filled material, but on the whole it is satisfactory. Texas rock asphalt 2 in. thick on a 6-in. reinforced-concrete base was used in the shed and on wharf No. 4. This has had one year's traffic by the United States aviation depot,



WHARF NO. 4, AT HOUSTON, TEXAS, WITH HEADFRAME AND RAMP FOR CARGO CONVEYORS

consisting of electric freight trucks and garage for Army motor trucks.

Concrete 6 in. thick is used in the municipal warehouse. This is a 1:2:4 mixture, with a special hardening finish for the surface, and the slab was covered for seven days with a ½-in. layer of sand which was kept moist. This paving has proved satisfactory under one year's service as the aviation depot. Rolled oyster shells in the cotton sheds require timber runways for trucking.

Freight-handling equipment is provided mainly at wharf No. 4, with the shed and warehouse. Three inclined platform conveyors are provided on the wharf to assist in loading and unloading cargo. They lie in inclined gangways. Each conveyor is pivoted at the inner end and has the outbound end suspended by cables from the steel headframe on the edge of the wharf, so that this end can be adjusted to the level of a ship's deck or cargo port. In the freight shed are two 8-ton electric freight elevators serving the bridges to the warehouse. For handling heavy freight, there is a 20-ton, 50-ft. overhead electric traveling crane in a covered craneway extending across one end of the wharf. This is at such a height that the runway extends into the warehouse, the crane thus serving ships, the wharf,

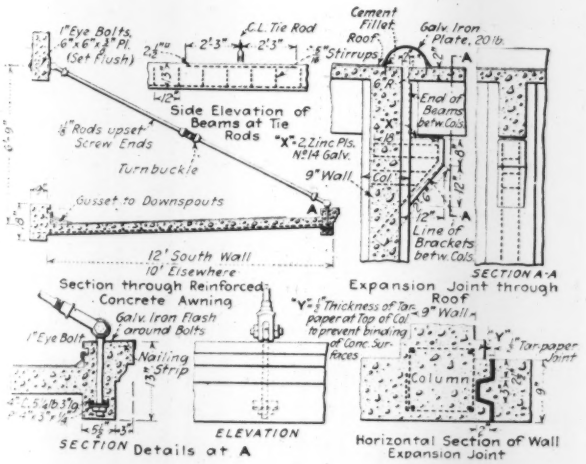
the railway tracks and the warehouse. At wharf No. 1 there is a single inclined conveyor for handling cargo. A monorail trolley system serves the cotton sheds and wharf.

Railway trackage in the vicinity of the turning basin aggregated 8.5 miles, including a storage yard providing capacity for 586 cars, but exclusive of extensions built to refining plants. Traffic is handled over the Houston Municipal Railway under an operating agreement with the Houston Belt & Terminal Ry. Co. The city owns two 70-ton switch engines and a two-stall engine house and is prepared to operate its yard, but for the present it is thought best to allow the company to perform the necessary service.

Fresh water is supplied from two artesian wells to a 150,000-gal. elevated tank. Sprinkler equipment is provided in the warehouse while 62 hydrants are arranged around the building and yards. This service is supplied by two electrically-driven fire pumps having a combined capacity of 2000 gal. per minute at 100-lb. pressure.

The ship channel was excavated through the shallow bay and across low swampy ground for about 35 miles; for the remainder of the distance it was between banks fairly close together and with an average height of 35 ft. No rock was encountered. Suction dredges removed the clay and pumped it through pipe lines to spoil banks. The depth is 25 ft. with a width of 150 ft. in the bay and 100 ft. in the upper portion. Curves have a radius of 2500 ft. or over. Improvements about to be started by the United States Government consist in increasing the depth of 30 ft. for a width of 250 ft. across the bay and 150 ft. above, at the same time easing the curves to 3000-ft. radius.

Expenditures since the first improvement was authorized in 1872 until June 30, 1918, aggregate $6,725,000, of which $5,346,000 was for new work and the balance for maintenance. Of this total the community



EXPANSION JOINTS AND CONCRETE AWNING OF MUNICIPAL WAREHOUSE

paid $1,409,176. The enlargement of the channel by the Government will cost $3,850,000 of which $1,365,000 will be paid from a bond issue of $1,500,000 authorized in May, 1919, by the Harris County navigation district. Maintenance is undertaken by the United States Government, with an annual appropriation of $325,000 for the necessary dredges. This development has resulted in creating a large industrial center, the plants located along the channel including several oil refineries and cotton stores, a portland cement plant and a chemical plant. During 1918 about 2,388,000 tons of merchandise valued at $116,332,000 were moved through the channel by over 15,000 trips of steamers, barges and other vessels.

Port and terminal facilities as now provided are considered ample for the next few years, except that a grain elevator and cotton compress are desirable. Design and construction of the present works were under the direction of E. E. Sands, city engineer, and J. C. McVea, assistant engineer, who has recently succeeded the former as city engineer. E. A. Fretz and H. H. Blake were resident engineers in charge of construction. The municipal warehouse was built by the American Construction Co. and all other structures were built by Horton & Horton.

Control Over Factory Wastes in Wisconsin

FOR the control of the treatment of industrial wastes in Wisconsin the State Board of Health has prepared a list of requirements for the construction and operation of plants for treating various classes of wastes. A copy of these requirements, we are informed by E. J. Tully, state sanitary engineer, is submitted to each concern installing a waste-treatment plant for signature by a responsible official. Of the two witnesses to the signature required one must be the local health officer. The recommendations for the treatment of creamery and cheese-factory wastes follow:

Requirements To Be Fulfilled by Officials of Company in Regard to Construction, Operation and Supervision of Treatment System for Creamery and Cheese-Factory Wastes

Satisfactory purification may be accomplished by definitely following instructions prescribed covering construction, operation and care of treatment system outlined. The State Board of Health, however, does not assume any responsibility in regard to purification. In order to obtain effective treatment, intelligent supervision over the operation of the system is essential, consequently it is necessary for the officials of a company installing a treatment system to agree to fulfill the instructions given below.

Construction—The system shall be constructed in detail as outlined.

Chemical Application—Such preliminary chemical treatment as planned is simple in application. Lime or soda ash, or both, shall be prepared and applied as directed.

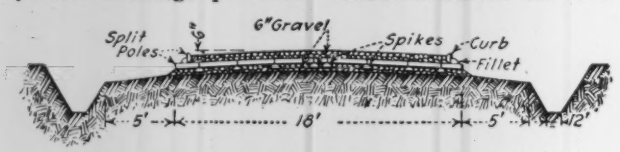
Supervision of Operation of Tank—Scum shall be removed from the sedimentation chambers of the tank once a month and the sludge or deposit shall be removed from each chamber every four to six months, or more often if necessary. Scum and sludge shall be buried, after liming. (The sludge shall in any case be removed when its depth equals one-fourth the depth of the tank.) The surface of the contact filter shall be raked each week.

Supervision of Operation of Gravel Filter—It is necessary in order to prevent clogging of the filters to regularly rake the surface of the sand and occasionally to remove, wash and replace about one inch of material from the surface of the filter. The filter, therefore, shall be raked each week; and about one inch of the surface filtering layer shall be occasionally removed, washed and replaced at least once every four months.

Witness..... Signature.....
Witness..... Title of Official.....
Date.....

British Army Timber Roads in France With Split Poles and Sleepers

CROSS-SECTIONS of the split pole and sleeper roads used by the British forces in France were shown in the June 19 issue of the *Surveyor* of London. One of the striking elements of the construction is the perfect drainage provided. The illustration shows a



GRAVEL ROAD REINFORCED WITH SPLIT POLES USED BY BRITISH FORCES IN FRANCE

cross-section of the split-pole road which consists of gravel reinforced with timber.

After grading as shown, a blanket of gravel is placed over the road 6 in. deep and eight split-pole sleepers are laid longitudinally. These are covered solidly with split poles laid crosswise. Edgings of split poles with fillet supports are used at the sides. The entire construction is then covered with gravel up to the top of the edgings.

Sleeper roads were built in the same form, with the exception that the timber used was 6 in. thick and square.

The timber used on the sleeper roads was bedded in sand, but the flooring was not covered with gravel and the traffic operated directly on the wood. In the sleeper construction a crown of 2 in. was used, instead of 6 in., as on the gravel-covered split-pole roads. In both types of construction deep ditches were used, and the gravel and sand facilitated perfect drainage to the gutter.

Charted Summary of State Concrete-Road Specifications

Information Arranged for Quick Determination of the Main Features — Explanation of and Comments on Chart

BY A. N. JOHNSON
Consulting Highway Engineer, Portland Cement Association, Chicago, Ill.

ACCOMPANYING this article is a charted summary of state highway specifications for concrete roads, which shows at a glance the main features of the latest obtainable specifications of the various highway departments. This chart is not complete, as a few state highway departments have prepared no specifications for concrete roads, while a few others have not responded to requests for copies. However, adequate information is given to show the trend in the practice of constructing concrete roads.

A word of explanation as to the make-up of the chart will make it clear. The headings of the columns indicate the subjects. Where practice is divided between but two or three variations, the column headings so indicate, and those states specifying a particular method are indicated by a dash in the appropriate column. Thus, the relative number of states following the one or the other practice in a given particular is readily seen. Where the variations are greater in number and such variations could be represented numerically, the different sizes, distances or proportions are inserted under the proper column heading, which also shows the unit of measure represented by the numerals.

In general, where blank spaces occur opposite a state name under all the column captions covering a given subject, it indicates the specifications for such a state are silent upon the subject.

SUMMARY OF VARIOUS STATE HIGHWAY DEPART

STATE	FINE AGGREGATE.			COARSE AGGREGATE			MIXING						CONSISTENCY		COLD WEATHER		FORMS		
	Grading Specified by Sizes	Grading General Only	All to Pass ... Inches	French Coeff. Bull. 102	Max. Size Inches	Min. Size Inches	Cement Factor Bbls. per Cu. Yd. Bull. 102	Proportions.	Time of Mix. Minutes.	Materials to be Measured	Water to be Measured	Mixer Timing Device	Mixer-Water Measuring Device	General Profiles Only	Specific Requirements	Work Prohibited	Work Permitted with Precaution	Wood	Steel	To be Oiled or Soaked
ALABAMA	—		¼	6	2	¼		1-2-3	1	—	—	—	—	—			—	—	—	
ARIZONA	—		¼	10	2	¼		1-2-4	1	—	—	—	—	—		—		—	—	
ARKANSAS	—		¾	10	1¾	¾		1-2-3	1	—	—		—	—		—		—	—	—
CALIFORNIA	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
COLORADO	—		¾		2	¼	1.70	1-2-3	1	GENERAL	GENERAL			—		—		—	—	
CONNECTICUT	—				1¼	½		1-2-4	1½	—				—		—		—	—	
DELAWARE	—		½	12	2	¼		1-2-4	¾					—		—			—	
FLORIDA	—		¼	10	2	⅛		1-2-3	1	—	—		—	—			—	—	—	—
GEORGIA	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
IDAHO	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
ILLINOIS	—		1.5-¾-¼	6	6-2.5-2½	¼	1.61	1-2-3½	1	—	—			—	—	—		—	—	—
INDIANA	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
IOWA	—		¼		1½	¼	1.70	1-2-3	1½	—	—			—		—		—	—	
KANSAS		—	¼	6 8	1½	¼	1.40-1.61	1-2-3½	1	—	—			—		—		—	—	
KENTUCKY	—		¼	10	2	¼		1-2-3	½	—	—	—	—	—			—	—	—	
LOUISIANA	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
MAINE	—		¼		2½	¼		1-2-4	¾					—		—		—	—	
MARYLAND	—		¼		2½	¼		1-2-3 to 1-3-5	¾ to 1		—			—				—	—	—
MASSACHUSETTS	—		¼		1½	¼		1-2-4	1					—			—	—	—	
MICHIGAN	—		¼		6-2.5-2½	¼		1-1½-3 to 1-2½-3½	1	—	—			—				—	—	
MINNESOTA	—	·	¼	8	2	¼		1-2-3½ to 1-2-3¾	1	—	—			—	—			—	—	
MISSISSIPPI	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
MISSOURI	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
MONTANA	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
NEBRASKA	—		¾	8	2	¼	1.70	1-2-3	1	—	—			—				—	—	—
NEVADA	—		¼	8	2½	¼		1-2-4	1	—	—		—	—				—	—	
NEW HAMPSHIRE	—		¼		2	¼		1-2-3	1½	—	—		—	—				—	—	
NEW JERSEY	—		¼		1½	6-4.5-¾	1.51-1.91	1-2-3	1½	—	—			—				—	—	
NEW MEXICO	—		¾	8	2	½		1-2-3	1½	—	—			—				—	—	
NEW YORK	—		¼		2½	¾		1-1½-3	1	GENERAL				—			—	GENERAL	NOT SPECIFIC	
NORTH CAROLINA	—		½		2	¼		1-2½-3	¾			—	—	—		—		—	—	
NORTH DAKOTA	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
OHIO	—		¼	8	2½	¾	1.75-2.0	1-1½-3	1	—	—	—	—	—			—	—	—	
OKLAHOMA	—	—	¼	7½	2	¼		1-2-3	1½	—	—	—	—	—		—		—	—	
OREGON	—		¾		6-4.5-2½	¼		1-1½-3	1	—				—		—		GENERAL	NOT SPECIFIC	
PENNSYLVANIA	—		¼	10	2	¼		1-2-3	1½	—	—	—	—	—		—		—	—	
RHODE ISLAND										—				—		—		—	—	
SOUTH CAROLINA	—		¾		1½	¾		1-2-4	1					—			—	—	—	
SOUTH DAKOTA	—		¾		2	¼	1.70	1-1½-3	1	—				—			—			
TENNESSEE	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
TEXAS	—		¾	8	2	¼		1-2-3	1½	—	—	—	—	—		—		—	—	
UTAH		—	¼		2	¼	1.68	1-1½-3½	1	—	—			—		—		—	—	
VERMONT	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
VIRGINIA	—		¾		2	¾		1-2-4	1	—	—	—		—		—		—	—	
WASHINGTON	—		¾		3	½	1.60	1-2-3	1	—	—			—		—		—	—	
WEST VIRGINIA	—		¾		2½	¾		1-2-3	1	—	—	—	—	—			—	—	—	
WISCONSIN	—		¼	7	2	¼	1.68	1-2-3½	1	—	—			—				—	—	
WYOMING	—		⅛		2	¼	1.70	1-2-3	1	—				—		—		—	—	

NOTE: States from which specifications were not available shown thus, ○ ○ ○ ○
Otherwise, a blank space indicates that the specifications are silent on the particular subject indicated at top of column

The printed specifications for a number of states refer to the plans for the details and exact manner in which a certain feature is to be executed. Such occurrences have been so indicated upon the chart; but in those instances not so clear or accurate an indication of the actual practice among the various states is gained. This is particularly true in regard to the reinforcement, thickness of slab, superelevation at turns and other features, about which but little information is gained from the text of the specifications.

Attention is directed to the relatively large proportion of specifications which call for a definite grading by sizes, for fine aggregate. The results of very extended investigations made by Prof. D. A. Abrams at Lewis Institute, Chicago, have shown that these arbitrary divisions of fine aggregate by sizes do not necessarily give a grading that will produce the best concrete or, in fact, be a measure to indicate the quality of the aggregate; and that if many of the gradings specified for fine aggregate were strictly followed it would result in the rejection of much material from which as good concrete could be made as with material that would be accepted under a particular specification.

The French coefficient for wear for coarse aggregate is specified in perhaps a third of the specifications. The requirements vary from 12 to 6. The use of the French coefficient for the purpose of determining aggregate for concrete roads is apt to be somewhat misleading and incomplete. The French coefficient of wear was developed to determine to relative value of crushed rocks for macadam-road work, and, due to the fact that the action of traffic upon aggregate in a concrete road is much different from that in a macadam road, this leads to some misinterpretation. Also, as the test cannot be made upon gravels which are used for coarse aggregate in so much concrete work, its application is incomplete. It is probable that investigations now under way will make possible more uniform requirements in this particular; but it may be pointed out that rock which tests not over 6 or 7 is in successful use in many miles of concrete roads.

In the mixing there is a very general agreement as to the proportions to be used, the majority of specifications calling for a 1 : 2 : 3 mixture. Most specifications now indicate the time for mixing, the larger number prescribing 1 min., while 10 states require 1½ min. and but one or two as short a time as ¾ minute.

The measuring of materials is generally emphasized, and specific requirements as to how this shall be done are found in many specifications. There is an increasing tendency to require special timing devices and water-measuring devices. Nearly all the state specifications prohibit laying concrete in freezing weather, while a few allow the work to proceed with special precautions.

There is a wide divergence in the provisions for joints. Four states specify no expansion joints at all, the others requiring expansion joints spaced at intervals varying from 25 to 40 ft. The provisions for finishing afford interesting comparisons, the general tendency being to provide those methods which will insure a dense and true surface. Thus, a few states provide for a split templet to be used at the joints, which is an excellent feature. A majority has adopted the roller-and-belt finish, also for a split float to be used at joints. Four states provide for a machine-finished surface.

Provisions regarding the variation from a true surface are lacking in a number of state specifications, while a number make requirements that are so indefinite as to be impracticable. For example, the provision

MENT SPECIFICATIONS FOR CONCRETE ROADS

EXPANSION JOINTS				No Joints, End of Day Only.	REINFORCEMENT			FINISHING							TRUENESS OF SURFACE		CURING				
Specified	Spacing in Feet	Steel Protection Plates	Thickness of Material Inches	Details on Plans	Specified	Mesh Lbs. Per 100 Sq. Ft.	Circumferencial Specified	Struck With Template	Split Template at Joints	Wood Floats	Surface Broomed	Roller and Belt	Split Float at Joints	Machine Finish	General Provision Only	Allowance of Variation Inch to Feet	Canvas Cover	Wet Earth	Ponding	Kept Covered Min. Days	Closed to Traffic Min. Days
—	—		¼ - ½	—				—				—	—				—	—		18	21
—	30		¼ - ½	—	When Used	25		—				—	—				—	—	—	15 - 18	15 - 21
—	37½		¼ - ½					—				—	—				—	—		7	14
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
—	30		¼					—				—	—			¼ —	—	—		10	14
—	25		⅛					—		—	—							—		8	8
—					See Plans			—				—						—		14	30
—			½ - ½	—				—				—	—					—		18	21
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
—				—				—				—		—		¼ —	—	—	—	14	30
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
—	36		⅛		When Used			—		—				—		¼ - ⅜		—		10	14
—	33⅓		¼ - ⅜		When Used	4.5		—				—	—			¼ —	—	—	—	14	30
—			½ - ½	—	See Plans			—				—	—			⅜ — ½	—	—		14	17
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
—	50		½					—		—						¼ —		—			
—				—				—	—			Belt						—		10	10
—								—		—	—							—		13	14
—			⅛	—				—				—	—			⅜ — ½		—		14	14
—				—	—	—	—	—				—	—	—		½ — ¾		—		14	21
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
—	35		⅛					—				—	—					—		10	14
—	25		¼					—				—	—					—	—	12	21
—	40		¼ - ½		When Used	25		—				—	—				—	—		18	21
—	36		⅜ - ⅝		When Used	3.4		—				—	—					—		10	14
—	30		½ - ½		When Used	2.5		—				—	—				—	—		18	21
—	30		½ - ⅝					—		—	—					½ - 10		—		14	14
—	40		⅝ - ½		When Used	2.5		—				—	—				—	—		16	21
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
—	40		¼ - ½		When Used	2.8		—				—	—			½ - 10		—		10	21
—	40		½ - ½		When Used	2.5		—				—	—					—		18	18
—	30			—	See Plans			—		—	—							—		10	21
—	200 + 600		½	—	When Used	2.5		—				—	—	—				—		18	21
—	30		¼ - ½					—		—	—							—		14	14
—			¼ - ⅜	—	See Plans			—	—			—				¼ - 3		—		10	14
—	36		⅛					—					—			¼ —		—		10	14
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
—	40		¼ - ½	—	When Used	2.5		—				—	—					—		18	21
—	40		⅜ - ⅝				—	—				—	—			¼ —		—	—	14	30
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
—	40		¼ - ½					—				—	—					—		13	21
—	30		⅜		When Used	2.8		—				—	—					—		10	30
—	30		¼ - ½			2.5		—				—	—					—		10	14
—			¼ - ⅜					—	—			—	—			¼ —		—	—	11	14
—	30		⅜					—				—	—			½ —		—		10	14

that the surface shall not vary over ¼ in., without stating the length within which such variation may be allowed, is not a workable specification.

The specifications of a few states make more definite the variation to be permitted, from ¼ in. in 3 ft. to ½ in. in 6 ft., while a number provide for ½ in. in 10 ft. In a few the allowable variation is ½ in. in 10 ft. and not greater than ¾ in. in any 3 ft. This is an important feature of concrete-road building and one to which more attention should be given in the specifications.

Requirements that the concrete be covered with wet earth are general. In a few instances, ponding is specified. This latter method has a much wider application than the few instances where it is specified would indicate. Most states require that the concrete shall be covered from 10 days to two weeks. In one instance it is as low as eight days. There is more variation as to the time a road is to be kept closed to traffic, the limits prescribed being between eight days, which is much too short a time, and 30 days.

Provisions for Consistency

Because of its importance, comment regarding provisions for consistency has been reserved to the last. While there is some mention made of consistency in practically all specifications, it is at most but general, and gives no adequate means by which to determine what the consistency shall be.

The consistency of concrete depends upon the amount of water used with a given amount of materials. It is also well known that the strength of concrete is directly dependent upon the quantity of water used, which should be as little as will give a concrete practicable to handle. Thus, the strength of the concrete depends upon the consistency.

The Illinois specifications (edition of April, 1919), alone give any definite measure by which to determine the consistency; this section is as follows:

569. The consistency of the concrete shall be determined by the following test: A cylinder 6 in. in diameter and 12 in. in length shall be filled with concrete which shall be tamped until all voids are filled and a slight film of mortar appears on the surface. The cylinder shall then be removed and the vertical settlement or "slump" of the concrete noted. This settlement shall not exceed 2 in. when the mechanical finishing machine is to be used and shall not exceed 4 in. when the finishing is to be done by other methods permitted in the specifications.

Bonus for Wisconsin Road Patrol

Patrolmen on road maintenance in Wisconsin who do satisfactory work this year, and who remain in service until the end of the season, will be paid a bonus of $5 per month. By April the necessary men had been hired, and preparations made for the maintenance work, under the direction of A. R. Hirst, state highway engineer. The men employed last year were classified as excellent, good, fair and poor. None of the last class have been reëngaged and only those in the "fair" class who appeared to be capable of improvement. All those of the other classes who desire reëmployment have been hired. The wages are somewhat higher than last year. Men were secured with less difficulty than in 1918; this is, possibly, due in part to the increased salary and bonus, but Mr. Hirst is of the opinion that it is due largely to a growing recognition of the fact that the patrolman's position is a desirable one.

Diagrams for Excess Loss of Head in Pipe Lines

Losses Due to 90-Degree Bends, Increasers, Gate Valves, Reducers and Branches Readily Found — Examples Given

By Frank S. Bailey
Assistant Engineer, Metcalf & Eddy, Boston, Mass.

DIAGRAMS for the purpose of quickly finding losses of head due to 90° bends of various radii, and also the losses of head which occur at increasers, reducers, gate valves or branches in a pipe line, have been prepared by the writer, and are here reproduced. When water flows at a low velocity, say 3 ft. per second or less, through one bend or special fitting, the loss of head is small, and if the pipe line consists mainly of long lengths of straight pipe the loss of head caused by friction in the straight pipe is comparatively so large that the loss in a few bends may be safely ignored. But in complicated systems of piping, such as are found in large office buildings, manufacturing plants, fire-sprinkling systems, sprinkling filters with dosing tanks, etc., which contain numerous bends and branches, the aggregate losses may sometimes reach a surprisingly high amount. In all such systems the losses of head must be carefully estimated and allowed for, or the system will prove to be inadequate to deliver water at the rate required.

Fig. 1 shows the loss of head, in feet, in 90° bends with radii varying from 0 to 60 ft. and also the head lost in gate valves, increasers, and in passing openings. The lines for the 90° bends were plotted from the formula $H = KV^{2.25}$, in which H is loss of head in

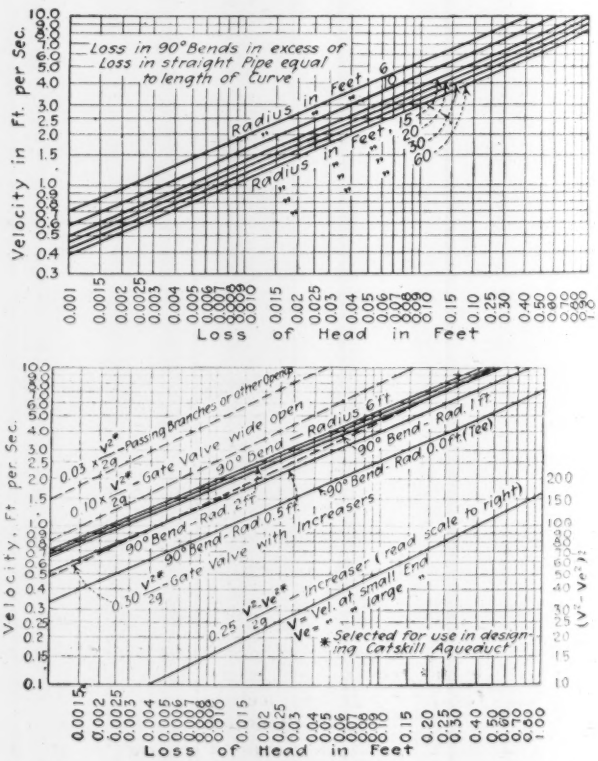

Loss in 90° Bends in excess of Loss in straight Pipe equal to length of curve
Radius in Feet 6
" " 10
" " 15
" " 20
" " 30
" " 60
Velocity in Ft. per Sec.
Loss of Head in Feet
0.03 x V²/2g - Passing Branches or other Openings
V²/2g - Gate Valve wide open
90° bend - Radius 6 ft.
0.10 x V²/2g
90° Bend - Rad. 2 ft.
90° Bend - Rad. 1 ft.
90° Bend - Rad. 0.5 ft.
90° Bend - Rad. 0.0 ft. (Tee)
0.30 V²/2g - Gate Valve with Increasers
0.25 V₁²-V₂²/2g - Increaser (read scale to right)
V₁ = Vel. at small End
V₂ = " " large "
* Selected for use in designing Catskill Aqueduct
(V₁²-V₂²)/2g

FIG. 1. EXCESS LOSS OF HEAD IN 90° BENDS, GATE VALVES, INCREASERS, ETC.

feet in a 90° bend in excess of the loss in a straight pipe of length equal to the length of the curve at the center of the pipe; K is a coefficient, different for bends of different radii, and V is velocity of water in feet per second. This formula was derived by W. E. Fuller and published in the *Journal* of the New England Water-Works Association for December, 1913.

To illustrate the use of the diagram: Assume that it is desired to know the excess loss of head in a pipe or conduit having a radius to the center line of 2 ft., the velocity of flow being 3 ft. per second. On the upper left-hand scale, Fig. 1, follow the horizontal line 3.0 to its intersection with the diagonal line marked "90° Bend—Radius 2 Ft." and then vertically upward to the scale giving loss of head, in this case 0.03 of a foot.

In cases where the 90° bends are of the standard American or New England Water Works Association patterns reference may be made to the writer's diagram published in *Engineering News* of Mar. 2, 1916, p. 412, where the loss of head in excess of the loss in straight pipe equal in length to the tangents of the curve at the center is shown, and also similar losses in malleable fittings.

The diagram printed herewith is of more extensive scope and shows the excess loss of head for 90° bends of any radius up to 60 ft., by interpolation. It will be noted that the diagram has two diagonal lines, each of which is marked "90° Bend—Radius 6 Ft." The reason for this is that the coefficient K in the formula cited above is a minimum for this radius; K increases as the radius diminishes from 6 ft., and also increases as the radius becomes larger; hence, the diagonal lines for different radii, if plotted together, would overlap so as to be indistinguishable.

How to Use the Diagrams

The formulas for finding head lost in wide-open gate valves, in gate valves with increasers, in passing branches or other openings, and in increasers, are those selected for use in designing the Catskill Aqueduct (see "Water-Works Handbook," by Flynn, Weston and Bogert, p. 583), and are also shown on Fig. 1. As an example, suppose it is desired to find the head lost in a wide-open gate valve, the velocity of flow being 7 ft. per second. On the upper left-hand scale find 7, follow horizontally to intersection with diagonal marked "Gate Valve Wide Open," then vertically upward to scale marked "Loss of Head in Feet," where the loss is seen to be 0.076 ft. To find head lost in gate valves with increasers, and head lost in passing branches or other openings, the scales used are the same as in the last example.

To find the head lost in increasers, it is first necessary to subtract the square of the velocity at the large end from the square of the velocity at the small end and obtain the square root of the difference, then on the scale at the right-hand side marked $(V^2 - V_c^2)^{\frac{1}{2}}$, we find the latter quantity and follow the horizontal line to its intersection with the diagonal marked "Increaser," thence vertically down to scale "Loss of Head in Feet," where the required result is given.

The formula for head lost in reducers, Fig. 2, is given in Merriman's "Treatise on Hydraulics," and applies chiefly to reducers which cause a sudden contraction of section in the direction of the flow, such as vitrified clay or short-body cast-iron reducers. For reducers causing a gradual contraction of section the loss of head is less than that given by the formula.

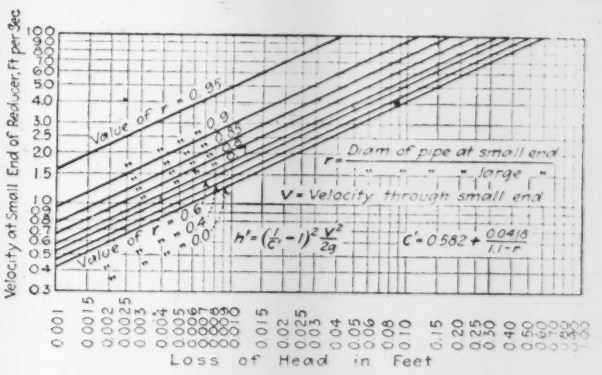

Velocity at Small End of Reducer, Ft per Sec
Value of r = 0.95
" " " = 0.9
" " " = 0.8
" " " = 0.6
" " " = 0.4
" " " = 0.0
r = Diam of pipe at small end / " " " " large "
V = Velocity through small end
$h' = (\frac{1}{c'} - 1)^2 \frac{V^2}{2g}$
$C' = 0.582 + \frac{0.0419}{1.1 - r}$
Loss of Head in Feet

FIG. 2. LOSS OF HEAD IN REDUCERS CAUSING SUDDEN CONTRACTION

As an example of the method of using this diagram, suppose it is desired to find the loss of head in a 10- to 8-in. vitrified-clay reducer (these reducers being of a pattern causing a sudden contraction) with a velocity of flow of 6 ft. per second at the 8-in. end. First find the value of r (diameter of pipe at small end divided by diameter at large end) which in this case equals 0.8; then on the left-hand scale find 6 and follow horizontally to the intersection with the diagonal marked "r-0.8," thence vertically downward to the scale "Loss of Head in Feet," where the loss is found to be 0.087 feet.

Fuller and Markmann's Formulas Compared

In connection with these diagrams, it is interesting to compare the results given by Mr. Fuller's formula for 90° bends with a formula derived theoretically by P. J. Markmann, which is referred to in *Engineering News* of Sept. 29, 1910, p. 328. In the example showing loss of head, as given by the Markmann formula, it is shown that the excess loss of head in a 90° bend of 2-ft. radius with a velocity of flow of 7.3 ft. per second would amount to 4.8 ft. The Fuller formula applied to these conditions gives an excess loss of head of only 0.23 ft. As the latter formula is simply an empirical one designed to agree with such experiments as have been reported—which it does—and as there is so great a difference between the two formulas, there is serious reason for doubting the reliability of the theory on which the Markmann formula is based.

It is not contended, however, that the formulas used in these diagrams will give absolutely accurate results in all cases; exceptional smoothness or roughness of the interior surfaces of bends or fittings will of course affect the loss of head by friction, and these as well as other variations from normal conditions may have an influence on the head lost by change of direction or velocity of the water.

Engine Terminals: Pennsylvania Lines

With reference to the article on "Engine Terminal Improvements: Pennsylvania Lines," in *Engineering News-Record* of July 3, 1919, page 24, Charles B. Johnson & Son, Chicago, state that they should have been mentioned as general contractors for the work at Logansport, Ind.

A Sliding Hillside at Cleveland

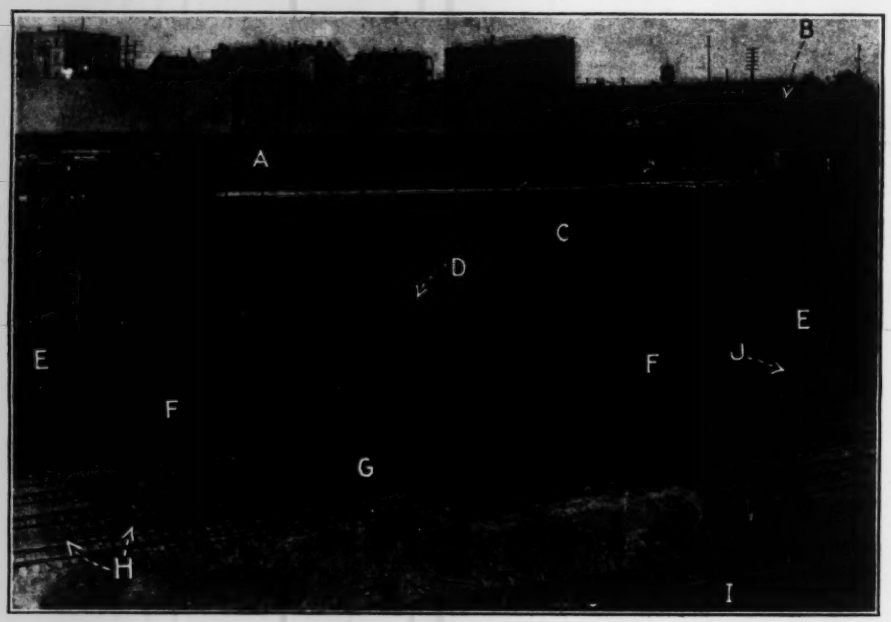
River Front Slope Moves Continuously, Partly Due to Dredging—Retaining Walls Bulged—Piling Checks Movement

LONG-CONTINUED sliding movement of a hillside along the Cuyahoga River at Cleveland, Ohio, has necessitated piling and other measures for the protection of tracks and structures of three railways which are benched along the slope at different levels, while the Wheeling & Lake Erie Ry. has had to rebuild the rest pier of its bascule bridge over the river. The situation is shown by the accompanying drawing and photograph. This movement has been in progress for about 35 years, and extends over a longitudinal distance of about 500 ft. The material is a medium grade of sand, with some quicksand, and the top of the hillside is about 100 ft. above the water level.

A 25-ft. concrete retaining wall 600 ft. long, on three rows of 40-ft. piles, was built in 1914 by the New York, Chicago & St. Louis Ry. to support its line on the upper bench. Up to the end of April, 1919, this had a maximum settlement of about two feet and a maximum outward movement of over three feet. Observations of these movements are recorded in the accompanying table; the figures that are given herewith are for the bottom of the wall; those for the top of the wall are somewhat less.

OUTWARD MOVEMENT OF RETAINING WALL BUILT IN 1914

Distance from West End	March, 1916	Jan., 1917	July, 1917	April, 1919
50	0.38	0.40	0.48	1.04
100	0.86	0.92	0.89	1.23
150	1.38	1.43	1.50	2.04
200	1.77	1.78	1.90	2.56
250	2.01	2.05	2.18	3.02
300	2.17	2.24	2.40	3.27
350	1.98	2.14	2.24	2.91
400	1.46	1.58	1.68	2.18
450	1.04	1.13	1.16	1.58
500	0.67	0.77	....	1.14



SLIDING HIGH GROUND CAUSES TROUBLE TO RAILROADS AT CLEVELAND, OHIO

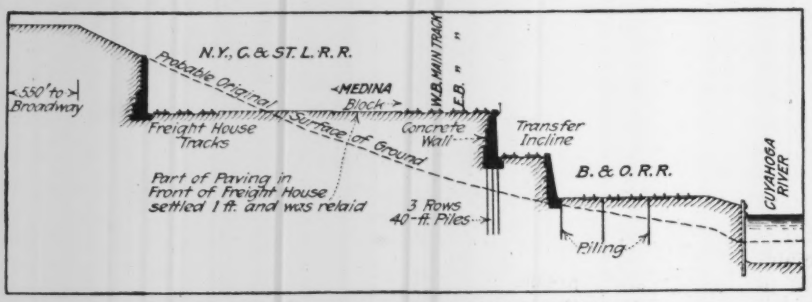
A. New York, Chicago & St. Louis Railway; B. Broadway; C. Concrete wall, 1914; D. Transfer incline; E. Stone wall; F. Concrete Wall, 1902; G. Baltimore and Ohio Railroad; H. Piles driven between tracks; I. Bulkhead wall along river; J. Piling driven 1882.

When this railway was built through Cleveland in 1882 the main tracks for several hundred feet east of the viaduct over the Cuyahoga River were carried on a pile trestle, and a dry rubble retaining wall was built to support the tail track of the transfer connection with the Baltimore & Ohio R. R. at a lower level. A short time after the wall was completed it was found necessary to drive piling in front to stop its outward movement. After a period of observation it was reported that this had been effective, and no further trouble was anticipated. In 1902, twenty years later, some 150 ft. of the rubble wall failed and was replaced by a concrete wall. The remainder of the wall, about 450 ft., shows considerable bulging.

The flood of 1913 washed away or weakened the shore-protection piling along the river front at this point, the location being at a sharp bend, so that the full force of the current was against this piling. Considerable movement of the hillside resulted before the Baltimore & Ohio R. R. could get new piling driven in the river; its engineers, therefore, drove rows of piles between the tracks as an emergency measure. As the City of Cleveland keeps the river dredged to a 23-ft. channel, this condition is favorable to continued movement of the hillside.

Among other effects noted are large cracks in a concrete freight office on the slope above the railways, these being due to both vertical and horizontal movement.

An elevated water tank of the Cleveland Provision Company, located near the foot of the slope, tipped toward the river a distance of about one and a half feet in its height of 24 feet and has been straightened.



CROSS-SECTION OF SLIDING HILLSIDE

South American Railways and the United States

Extensive Development Needed — Multiplicity of Gage Is a Complication — Opportunities for United States Capital

TRANSPORTATION conditions in South America and the United States have a general similarity in the average long distances to the seaports, owing to the great extent of the countries, compelling attention to grades and train loads, for economical operation. This was shown at the recent Pan-American Conference held in Washington, in an address by Percival Farquhar, who pointed out that trunk lines with low grades, capable of carrying heavy train loads, have permitted the carrying on of transportation in the United States at the lowest rates in the world.

One great problem that railways in new countries have to meet is the opening of undeveloped territory, in order to permit of its settlement. Without railways the development may be long delayed, and this has led many South American countries to encourage the construction of railways by a guarantee of interest on the capital necessary to construct them. Where this has taken the form of a guarantee per kilometer or per mile, it has led to the location of the railways with a view to cheap construction. In many cases the meter gage has been adopted, owing largely to the sharper curves which it is supposed to permit and to some small economies of construction. The penalty paid in the operation of the narrow-gage railway has increased with its length, but when once established it is difficult to change. In a country like Argentina, where in general there are no cuts, fills or bridges, the narrow gage adopted by some foreign railway interests and by the Argentine Government has no defense. On the bulk of the railways of Argentina, however, the gage is 5½ ft., but as the cars and locomotives are no wider than American standard-gage equipment these railways are deprived of the advantages of the heavier train loads which the wider gage should give them.

South America Needs Fuel

In fuel, South America has been handicapped, compared with the United States and with Europe. The increase of miners' wages and reduction of hours of labor in Wales, hitherto South America's chief source of supply, emphasize the need of developing local fuels. Pulverized Brazilian and Chilean coal gives good efficiency; there are great areas of oil on the east and west slopes of the Andes, and it is thought that oil may be found in other areas. Cheap fuel is a key to the problem of cheap transportation in South America, and it is not likely that it can be obtained from another hemisphere.

In addition to new construction, there is a vast amount of deferred betterment work on the existing railways, requiring additional rails, rolling stock, sidings and terminal facilities. Mr. Farquhar considers that Government management of the railways has been detrimental to their success.

The railways in Latin America have been financed almost entirely with European (especially British) capital, and the railway companies have been organized, as a rule, in the countries furnishing the capital. Mr. Farquhar pointed out that it cannot now be determined to what extent European countries will be able to finance the requirements of these companies, but it would seem that the demands for capital at home and in their colonies may not leave available sufficient funds for their railways in South America. In such case they may wish the United States to join in this financing and some method or plan should be worked out to provide for such assistance, which would benefit both the United States and the South American countries.

Concrete for Railway Track Support

CONCRETE railway roadbed construction as a means of affording a more substantial and permanent support for the track is an old idea brought up anew by the report of the ballast committee of the American Railway Engineering Association, although the committee does not discuss the subject but simply presents information. In many designs for such construction the concrete, in the form of a stringer or slab, is intended as a substitute for ballast. It has been proposed also to use a concrete slab as a base for the ballast, in order to distribute the load over the roadbed and to provide good drainage. In this latter case it would keep the subgrade dry and firm and prevent the loss of ballast which ordinarily becomes pounded into the roadbed, necessitating the continual addition of fresh material.

Concrete Tried as Direct Support for Track

An extensive trial of concrete as a direct support for the track, with the rails laid on wood blocks or stringers resting directly on concrete slabs, is being made on the Northern Pacific Ry., as described in *Engineering News-Record* of Dec. 12, 1918, p. 1071. This appears to be the only example of such construction on the open line. Experiments with a concrete slab placed between the ballast and the roadbed are more numerous, but are limited to short stretches under track crossings or interlocking plants. Concrete roadbed or track floor construction in large stations and in tunnels and subways is well established, but in such cases the subgrade problem is simple, as the factors of rain and storm are not involved and in some cases the slab is supported on steel floor framing. This unballasted track in a station has an advantage in promoting cleanliness, since the floor of the station can be swept and flushed.

Opinions of engineers in regard to concrete roadbed construction, as quoted in the report, are diverse and conflicting, as might be expected. Some see no value in it or make definite objections. One objection is the liability of disturbance due to settlement of fills, which may continue for several years and would make it difficult to maintain the track in surface. It is suggested also that slabs directly supporting the track would be cracked and shattered under heavy traffic, but this objection is not sustained by experience on the experimental track of the Northern Pacific Ry. On the other hand, several engineers consider the idea as promising, but most of these prefer the use of concrete as a base for the ballast and a protection for the roadbed, rather than as a direct support of the track or a substitute for ballast. Those both favorably and unfavorably impressed refer to the high cost of a continuous slab, but this would be offset to some extent by saving in cost of maintenance and reballasting.

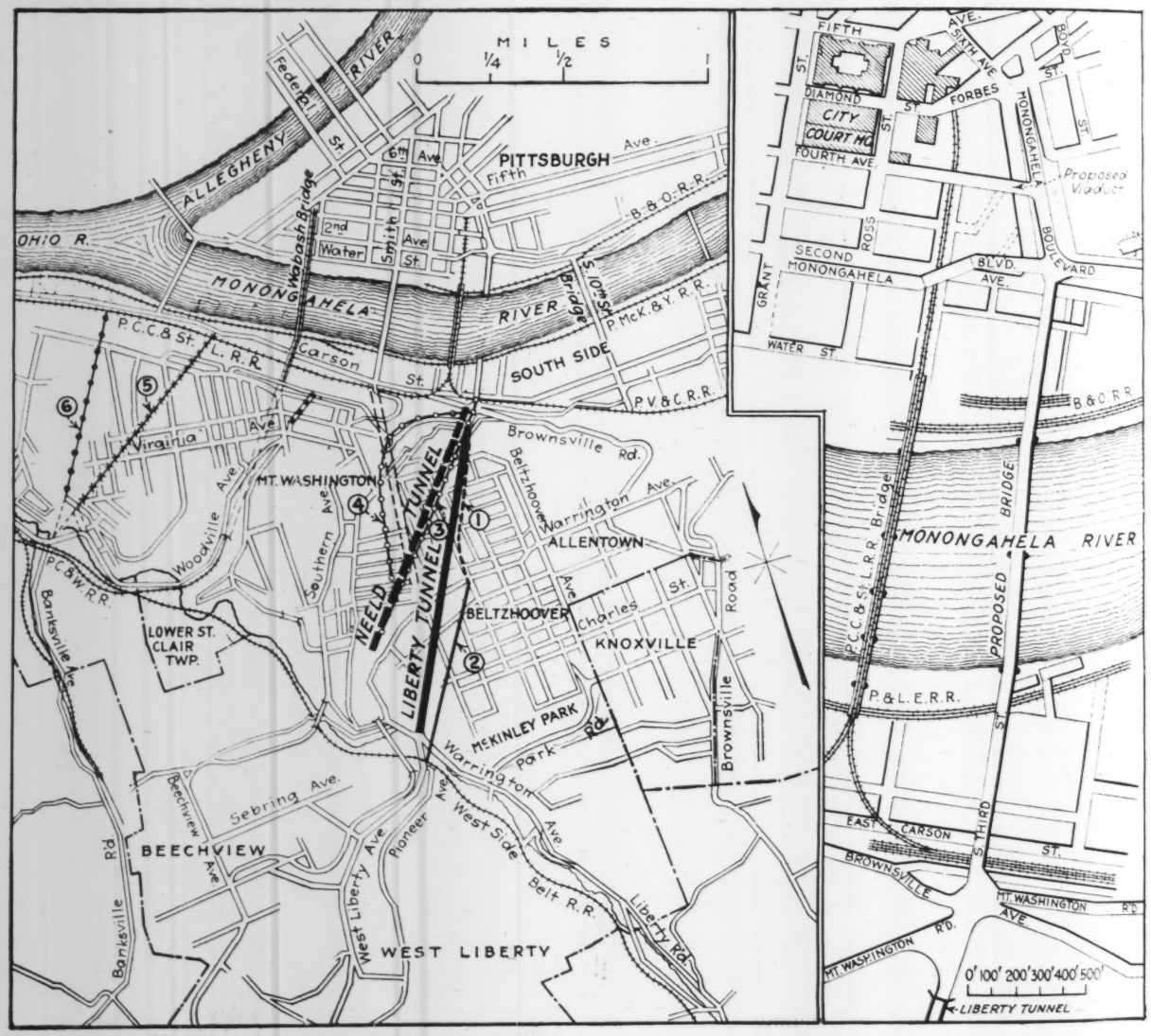
Pittsburgh South Hills Tunnel and Earlier Projects

Present Enterprise for 5500-Foot Tunnel and Its Predecessors—Approach From City By Way of New Bridge

WITH the recent decision of the county commissioners of Allegheny County (Pittsburgh) to contruct a highway tunnel, the "Liberty Tunnel," through the South Hills, connecting the south bank of the Monongahela River with the southerly suburban districts, a public question of long standing and important to the development of Pittsburgh is brought nearer final solution. Four or five years ago a similar tunnel enterprise (see "Neeld Tunnel," on map) was decided upon by the county, and construction was started, but the courts declared it unlawful. However, many other projects have been under discussion within the last dozen years.

Intimately connected with the question of the tunnel location is that of means of access to the tunnel from Pittsburgh. Some of the plans involved a new bridge across the Monongahela to take care of the tunnel traffic, while others depended on the traffic facilities of existing bridges, in most cases the Smithfield St. or the Tenth St. bridge. These are already heavily taxed, the former particularly. The project now adopted by the commissioners includes the construction of a new bridge; this will provide an outlet of large capacity from the business district to the South Hills territory.

In the two plans herewith, some of the chief features of the location and its relation to prior projects are made clear. The general map shows the line of the tunnel with relation to the business district of Pittsburgh, to the south bank of the Monongahela, and to the valley of Sawmill Run, in which the south terminus is located. The location was determined by the county planning commission, to whom the board of county commissioners had referred the question. Special studies were made by E. K. Morse and W. M. Donley. Gen. George W. Goethals was called in as an expert on



SOUTH HILLS TUNNEL LOCATION, PITTSBURGH, AND BRIDGE CONNECTION TO BUSINESS DISTRICT

References to South Hills Tunnel Projects; (1) Haberman tunnel; (2) Haberman tunnel extension; (3) Morse location; (4) Open-cut location; (5) Bigelow-Shalersville tunnel; (6) Alternate Shalersville project.

location, the bridge-approach question, and tunnel ventilation.

The adopted project comprises a tunnel 5500 ft. long extending from a point in the face of the riverside bluff at Brownsville Avenue and South 3rd Street to a point on West Liberty Avenue, near the Bell House Tavern, in Sawmill Run Valley. The profile shows a 2% grade ascending from the north portal for a distance of 2800 ft., and a 1.55% descending grade thence south. The tunnel is to be 44 ft. wide, providing for four lines of traffic, including street cars, and on either side a footwalk. The approach from the city is to be a high-level bridge 2660 ft. long, starting on the city side at Monongahela Boulevard about 800 ft. east of the corner of Sixth Avenue and Forbes Street, and extending to the north tunnel portal on a grade of 0.714%. The deck of the bridge will be 56 ft. above Second Avenue on the Pittsburgh side and 73 ft. above Carson Street on the south side. The city terminus of the bridge is practically the same as that of the Shingiss St. bridge proposed six or eight years ago by the late Hermann Laub as part of a South Hills tunnel project. It is close to the center of the business district and also leads directly into several avenues of traffic to the eastern residential district.

Of the earlier projects the most important is the Neeld tunnel, whose construction was begun by the county four years ago. Its north portal was located not far from that of the Liberty tunnel, but at a lower level, as it was intended to reach Carson St. at grade, and extended 4900 ft. on an ascending grade of 2.88% to a point 67 ft. below the grade of Warrington Ave. near the Pittsburgh Railways Co. car barns. In the present restudy of this location, the planning commission disapproved of the north portal location because of its connecting with Carson St. at grade and thereby interfering with traffic parallel to the river, and of the south portal location because of the heavy grade (6%) of the approach along Warrington Ave. from West Liberty Avenue.

Similar objections were held to condemn projects advanced by E. M. Bigelow for a tunnel from South First and Carson Sts., either to the Bell House portal location (6280 ft. long, with a rising grade of 2.12%) or to the same south portal as that of the Neeld tunnel (4800 ft. long, on a grade of 3.4%). Several projects developed by E. K. Morse, using the south portal location of the Neeld tunnel, were considered objectionable for similar reasons. Another study by Mr. Morse, indicated on the map as "open-cut" location, contemplated tunnel, viaduct, and open cut in combination. Beginning at Brownsville Ave. near South 3rd St., it proposed to ascend on a 5% grade along the face of the bluff, thence proceed southerly by 950 ft. of open cut, 500 ft. of tunnel, 1450 ft. of open cut (maximum depth 200 ft.) and finally, by surface and viaduct roadway including a 1200-ft. crossing over Sawmill Run, to West Liberty Ave. This project was disapproved because of "its heavy grades, indirect routes and viaducts, and the proposed depth of the open cuts."

The line marked "Haberman Tunnel" indicates a high-level project proposed ten or a dozen years ago by Hermann Laub and F. I. Gosser. This contemplated a short tunnel, 1900 ft. long, extending to high ground at Warrington and Haberman Aves., in combination with a double-deck bridge across the Monongahela. The upper deck of this bridge was to rise on a grade of 3.78% from Shingiss St., on the Pittsburgh side, to the north portal of the tunnel. The lower deck was to connect with Carson St., on the south-side river bank. The tunnel would have been about 80 ft. above the Liberty tunnel at the north portal, while its south portal would have been 184 ft. higher than the West Liberty Ave. portal. The Haberman Ave. project was discarded in the present studies because of its heavy grade, the height of the bridge, and the long climb from West Liberty Ave. to its south portal.

The finally adopted location was one of several worked out by W. M. Donley; one of the Donley projects is indicated on the map as "Haberman Tunnel Extension," a scheme which was intended to combine the advantages of access to Warrington Ave. with those of direct connection with Sawmill Run; it involved a total tunnel length of 4600 ft., in two sections separated by 1100 ft. of open cut. The adopted project, as already described, combines the advantages of a north portal above the level of interference with traffic on Carson St., an independent bridge route direct to the business district of the city, and a south portal centrally located in Sawmill Run Valley.

Detail plans for the work are now being prepared under direction of A. D. Neeld, who has been appointed engineer in charge of construction for the county commissioners. When completed the plans will be submitted to the Grand Jury for approval. It is expected that a contract can be awarded by October, and that actual construction can be started before the end of the year.

Lining a Reservoir With Concrete By the Cement Gun

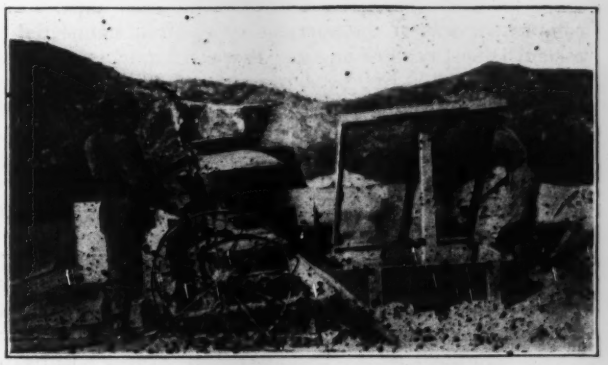
Costs and Progress Made, Given for Operations in Irrigation District During Current High-Price Period

By E. Court Eaton

Superintendent and Engineer, Lindsay-Strathmore Irrigation District, Lindsay, Calif.

CONCRETE lining of reservoirs has become accepted practice in a number of locations where subsoil is pervious and difficulty in holding the water level is anticipated. For such work the cement gun has, in this district, proved very successful, but the costs during the present high prices have not been well established. The accompanying figures are given as an indication of what such work cost on a recent job.

The Lindsay-Strathmore Irrigation District, which



SCREENING SAND ALONGSIDE OF THE CEMENT GUN

has just completed its first irrigating season, has a small reservoir covering about two acres and holding 18 acre-feet of water. The reservoir is known as a "balancing reservoir," and floats on one of the main pipe lines, being used to take up the daily fluctuations in flow, storing a surplus during part of the day, and supplying the shortage during the balance. Unfortunately, the location of this reservoir was necessarily confined to a certain area close to an old stream bed, and the reservoir is excavated in a gravel deposit and had a considerable loss due to seepage, amounting to two to three acre-feet per day. Difficulty was also experienced in making the banks hold, due to water undermining the loose material.

It was decided to line this reservoir with a gunite lining. The total area to be lined was 114,000 sq.ft., and specifications called for a gunite lining 1 in. in thickness, with a mix of one part of cement to 5½ parts of sand; no lime was used in the mixture. The lining was reinforced with galvanized poultry netting, 1½-in. mesh, No. 19-gage wire, placed in the center of the concrete to confine cracks due to expansion to hair cracks, and no expansion joints were used.

This work was let by contract at a price of 10½c. per square foot, including the trimming and preparation of the banks. Work was commenced Jan. 14, 1919, and completed Mar. 19. Because the work had to be done during the winter months the actual number of working days in this time was only 39.

The cement gun used was what is known as the N2 size. It was kept on the upper bank of the canal at a maximum distance of 600 ft. from the compressor, to which it was connected with a 2-in. iron pipe. The compressor was of the portable type, direct-connected to a semi-Diesel type of engine; it was 12 x 12 in. and ran at a speed of 300 r.p.m. A pressure of 42 lb. per square inch was maintained at the compressor, giving about 32 lb. at the gun. A 2-in. rubber hose 200 ft. in length was used from the gun to the nozzle, and the rubber tips in these nozzles lasted nearly one week before requiring replacement. The depreciation on the hose for the period of the job was $200.

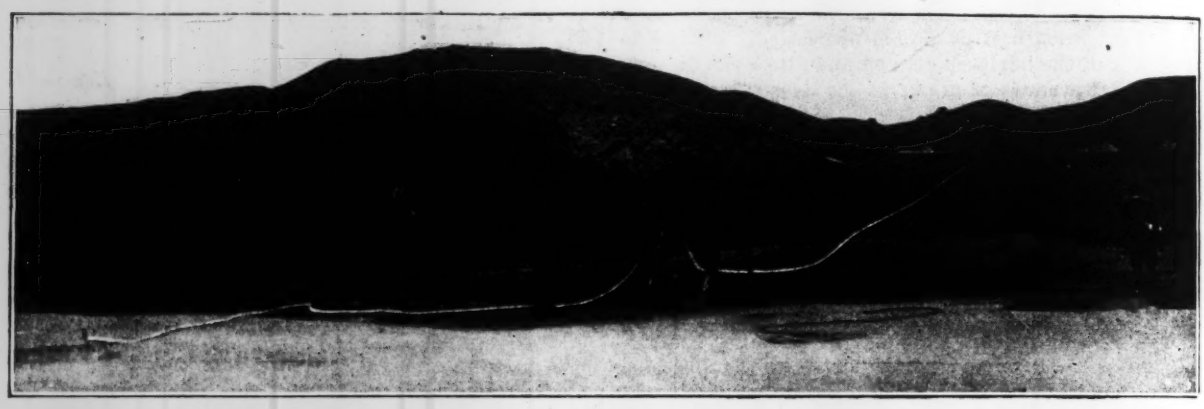
In lining the 114,000 sq.ft., 2904 sacks of cement were used, or nearly 39 sq.ft. of lining per sack of cement. The average rate of progress throughout the work was 2900 sq.ft. per working day. The maximum day's run was about 5000 sq.ft., though better average progress would have been made in the dry season, as the principal delays were due to wet sand clogging in the hose and necessitating frequent cleaning out of the machine. A certain amount of moisture is necessary in the sand for this class of work, and the best results were obtained when sufficient water was present so that the sand just failed to hold its shape when squeezed in the hand.

The total quantity of sand used on the work was 600 tons, and the total cost of sand per ton was as follows:

	Per Ton
Loading charge at sand pit	$0.30
Freight	.60
Unloading	.12
Hauling to site	1.50
Total	$2.52

The hauling over the wet roads a distance of two miles was the biggest item. The weight of a cubic yard of sand, which was wet, was 2500 pounds.

The cement was $3.45 per barrel delivered at the site, after an allowance of $1 per barrel was made for sacks. The poultry netting delivered at the site cost $1.17 per 100 square feet.



CEMENT GUN LOCATED ON BANK SUPPLYING NOZZLE COVERING RESERVOIR BOTTOM WITH CONCRETE

The construction crew employed was as follows:

	Per Day
1 Compressor engineer	$7.00
1 Nozzleman	5.00
1 Man placing wire	5.00
2 Mixers at $4	8.00
1 Man loading gun	4.00
1 Nozzleman helper	4.00
1 Gun operator	4.00
1 Man cleaning off rebound	4.00
Total payroll	$41.00

One man was kept continuously close to the nozzleman, his duties being to brush back the rebound at the junction of new and old work and to raise the reinforcement by means of a hook to insure its being placed in the center of the lining.

The fuel used consisted of a fuel oil having a gravity of 27+. Ten drums of this oil of 104-gal. capacity per drum were used. The cost of the oil was $6.55 per drum, delivered to site. The loss by rebound in percentage of the sand used was 8½; this was not wasted, however, as it was collected, screened and used over again with good results, except that only 30 sq.ft. of lining per sack of cement, or 23% less than with new sand, could be gotten when rebound was used, due to the material being coarse and requiring more cement to fill the voids.

Particular attention was paid to the curing, by sprinkling, of the newly completed lining for a period of two days, and up to this time no cracks other than fine hair cracks have developed.

Hexagonal Chart for Finding Velocity of Water in Pipes

Single Diagram Embraces Six Variable Quantities Without Using a Single Curve—Use of Transparent Index Suggested

By C. Warington Anthony
Bahia Blanca, Argentine Republic

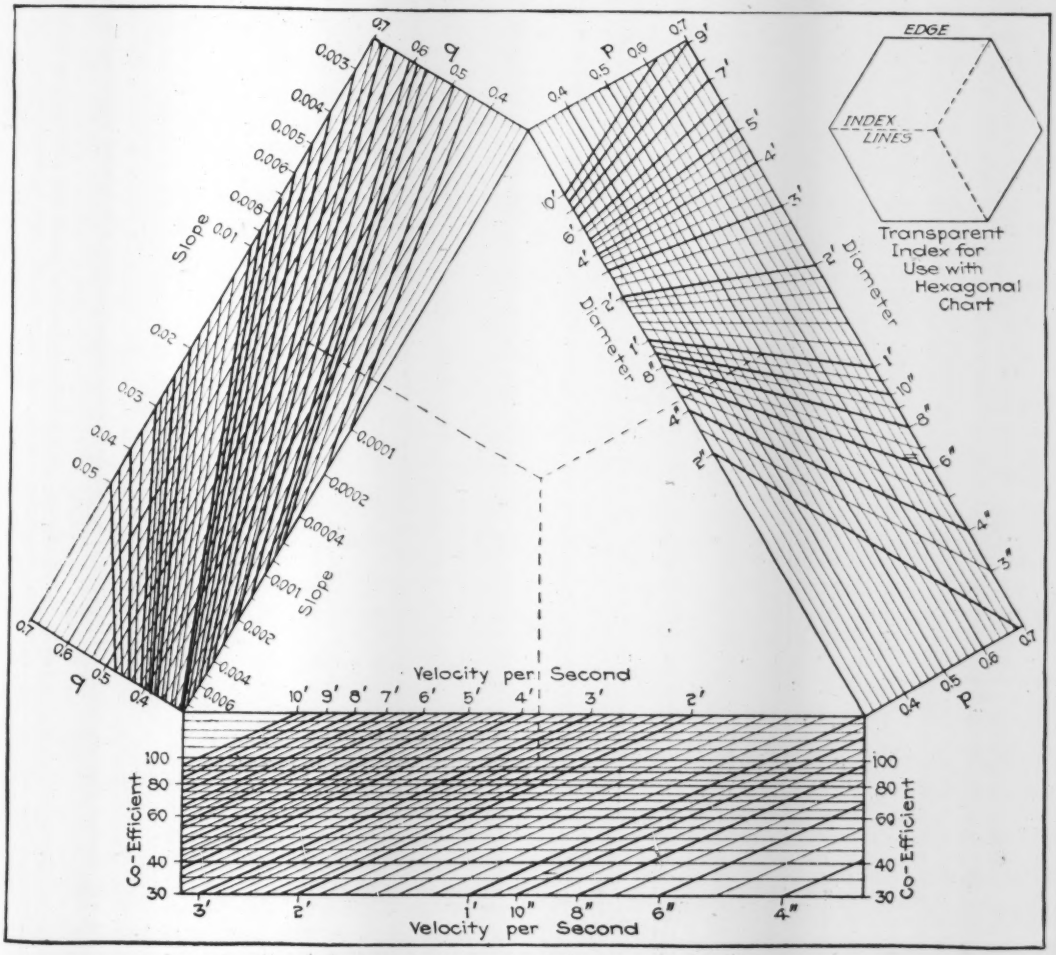
Exponential formulas are very much used nowadays in hydraulic problems dealing with the flow of water in pipes and sewers. Many charts or diagrams have been drawn to represent each formula, some taking a variable coefficient into account, which depends on the nature of the inner surface of the conduit, but the writer has never seen one made that does equally well for all the exponential formulas. For this reason I have designed a hexagonal chart that takes care of six variable quantities—the velocity of flow, coefficient of roughness, hydraulic mean radius and slope, together with the powers to which these last two quantities are raised—and yet in spite of all this apparent complexity this chart is as easy to handle as a chart made for working out only one kind of exponential formula. Evidently a chart of this description will prove of great value, since it may be used for rapidly computing and comparing results obtained for a given case by applying different formulas. It may also be used to deduce the best equation to fit in with the results of experiments that have actually been carried out.

The exponential formula is usually written: $V = C\,(D/4)^p\,S^q$, or $V = C\,R^p\,S^q$, since the hydraulic mean radius of a pipe flowing full is the fourth part of its diameter. There will be seen to be three binary scales in the chart, arranged in the form of an equilateral triangle. The coefficient and velocity go together on one scale, and the diameter and slope, together with their respective powers, on the other two scales. The way the diagram is used is illustrated with dotted lines for the following case:

Diameter, 1 ft.; slope, 0.0025; coefficient, 100, $p = q = \frac{1}{2}$. The velocity is seen to be $2\frac{1}{2}$ ft. per second.

When using the chart it is convenient to have a hexagonal transparent index, as shown in the upper right-hand corner of the illustration, with its sides parallel to the three index lines. By placing a straight-edge against one side, the index lines may be moved without changing their orientation or displacing the one parallel to the straight-edge.

The great beauty of the chart lies in the fact that it does not contain a single curve, which makes it much easier to draw and at the same time a high degree of accuracy is insured. This is attained by employing logarithmic instead of equally spaced coördinates.



HEXAGONAL DIAGRAM FOR FINDING VELOCITY OF WATER IN PIPES

Report on Cleveland Rapid Transit Recommends Street-Car Loop Subways

Consulting Engineers Find That Surface Relief Is First Need—Street-Car Loop System at Public Square Should Be Retained, but Capacity Increased by Placing Underground—Later Rapid-Transit System

IN REPORTING on rapid transit in Cleveland to the city's rapid transit commission, Barclay Parsons & Klapp, consulting engineers, New York City, have just recommended a system of loop subways for street cars in the center of the city, in order to deal with the transfer traffic now using the Public Square, and relieve the track and street congestion downtown, and also to create the nucleus of a future rapid-transit system. They find that Cleveland is in need of rapid transit, but express doubt as to the financial practicability of an adequate rapid-transit system. They outline a future rapid-transit system comprising an east-west subway line as main stem, and elevated or depressed (open-cut) extension lines; they do not recommend the construction of this system, however.

Improvement of street-car facilities is chosen in preference to rapid-transit construction at the present time for the following reason:

> The expense of attempting to reach all the various outlying residential districts from the heart of the city by subway or elevated lines would be so great as seriously to delay the materialization of these facilities. By utilizing the existing street-car systems, the suburban lines and parts of the rights-of-way and other facilities of the Union Terminal Co. in combination with city-built sections of subway in the business district, the minimum investment will produce adequate service and most economical operating costs.

Under the heading, "Physical Character of Proposed Rapid-Transit System," the engineers say, among other things:

> In the ultimate analysis the problem resolves itself into the question, "Shall the very successful and well arranged loop system in the Public Square which has satisfactorily handled the surface-car traffic in the past now be supplemented by exterior loops delivering passengers farther away from the center of the business district and only such cars be run to the Square as can be operated through the steadily increasing street congestion?" or, "Shall the facilities to and through this portion of the city be maintained and increased by suitable subsurface routes free from vehicle and pedestrian interference?"

The consulting engineers decide for the latter alternative. At the same time they indicate that no material increase of revenue is to be expected in return for the expenditure required to build the subway loops.

Three maps herewith, Figs. 1 to 3, summarize graphically the recommendations of the engineers. The street-car subway system is outlined in Fig. 1. This system is designed to increase the transportation capacity and speed of the present street-railway system by removing the street-car tracks from the surface, on the main lines approaching the Public Square, and substituting five underground loops for the four loops in the Square through which most of the city's street-car traffic passes at present. In detail the arrangement of the proposed loops is shown by the plan, Fig. 2. Short subway sections prolong these loops to points some distance away from the Square: On Euclid Ave. to 22nd St., on Ontario south to East 4th St., on Superior Ave. east to East 9th St. and west to the high-level bridge. This system is estimated to cost about $15,000,000 when built in four successive stages; built in a single operation it should be somewhat cheaper. As soon as possible the system is to be developed into a real rapid-transit system, a suggestion for which is given by the map, Fig. 3. The portion of lines shown in full black on this map represents subway lines, in extension of the initial Euclid Ave. and Superior Ave. sections connecting with the Public

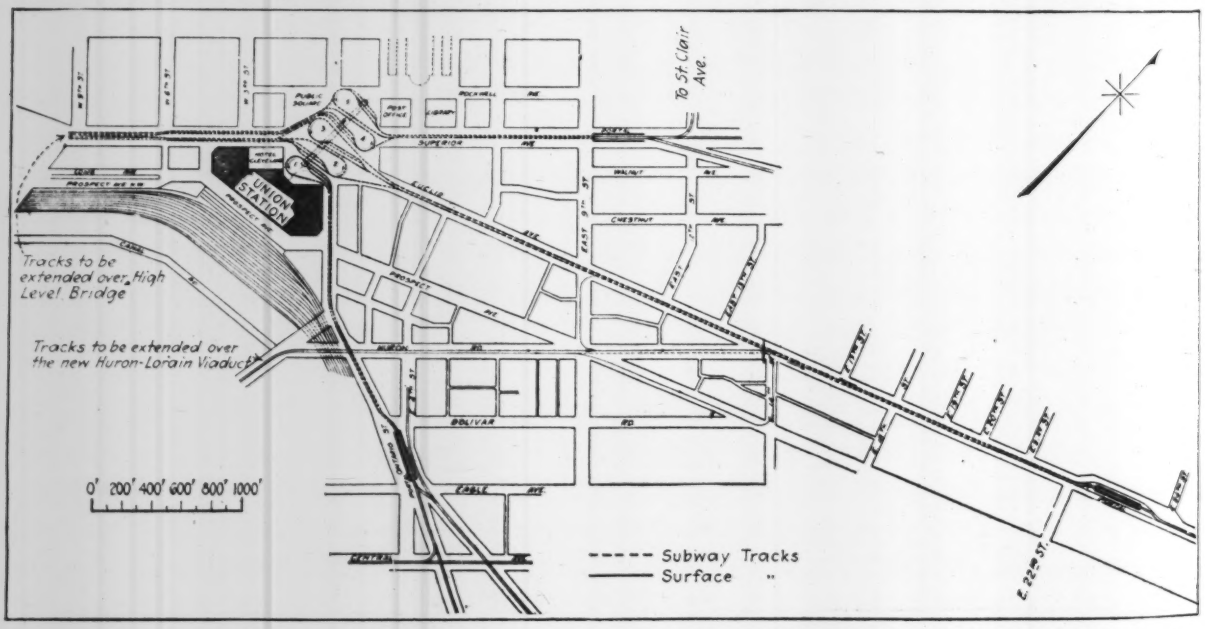

To St. Clair Ave.
UNION STATION
Tracks to be extended over High Level Bridge
Tracks to be extended over the new Huron-Lorain Viaduct
0' 200' 400' 600' 800' 1000'
Subway Tracks
Surface
E. 22nd St.

FIG. 1. PARSONS & KLAPP PLAN FOR PLACING STREET-CAR TRACKS IN CENTRAL SECTION OF CLEVELAND UNDERGROUND, WITH LOOPS UNDER PUBLIC SQUARE

Square loops, while the broken lines radiating out from this stem are elevated or open-cut extensions. This suggestion for a rapid-transit system is advanced tentatively, and no costs are estimated.

Finally, as an alternative to the Public Square loop system shown by Fig. 2, the engineers present a simpler system, Fig. 4, which could be constructed at lower cost; they do not recommend this two-loop system, however.

Among the essential data established in the preliminary investigation are these: With a present population of about 850,000, or about 971,000 in the metropolitan area, Cleveland may be expected to grow to 1,500,000 in 1930 and 2,000,000 in 1940. It is now practically at the point of development at which other large cities began rapid-transit construction. As the past growth of the city has been unusually steady, the predictions as to future development may be made confidently and plans developed accordingly. Diversified manufacturing, scattered widely over the city, and equally scattered residential development, and housing, have relation to the steadiness of development and affect traffic conditions.

Both in density of population and in traffic density the city is somewhat below other communities of similar size. Within the street-railway area there are about 18 inhabitants per acre, against 19 for Detroit, 20 for Chicago, and 26 for New York (164 for Manhattan). In spite of the fact that the manufacturing industries are scattered, and that many of the workers live nearby, a very large fraction of the passenger traffic passes through the Public Square, where the street-car lines loop back and passengers exchange. The rush-hour movement is very largely radial, therefore, with an exceedingly heavy congestion at the square. This concentration is partly due to the division of the city into east and west sides by the Cuyahoga River valley, and to topographical peculiarities of this valley which have heretofore tended to confine the business district to the immediate neighborhood of the Square. The engineers conclude, however, that this district will continue to grow eastward along Euclid Avenue.

Needed Traffic Improvements

Density of street-car traffic is not a distinguishing feature of Cleveland. The line of heaviest traffic, that on Euclid Ave., carries only 43,000,000 passengers per year, as against 72,000,000 on Woodward Ave., Detroit. This is in part, however, due to diversion of Euclid Ave. traffic to parallel lines. The traffic is largely long-haul, but the average length of ride with transfer, 3.1 miles, is less than in Chicago (4.16 miles).

Street-car traffic more than doubled in the past ten years, to nearly 400,000,000 passengers per year, and may be expected to increase to 740,000,000 by the time the population reaches 2,000,000; the number of rides per inhabitant is expected to increase from the present figure of something over 325 to about 370.

Comparison with Boston and Chicago shows that as these cities built their first rapid-transit lines when their population was close to the million mark, Cleveland "in the matter of population is at the stage where other cities entered upon development of their rapid-transit systems." However, they conclude that "the rapidly increasing vehicle and pedestrian congestion in and about the Square, together with the further

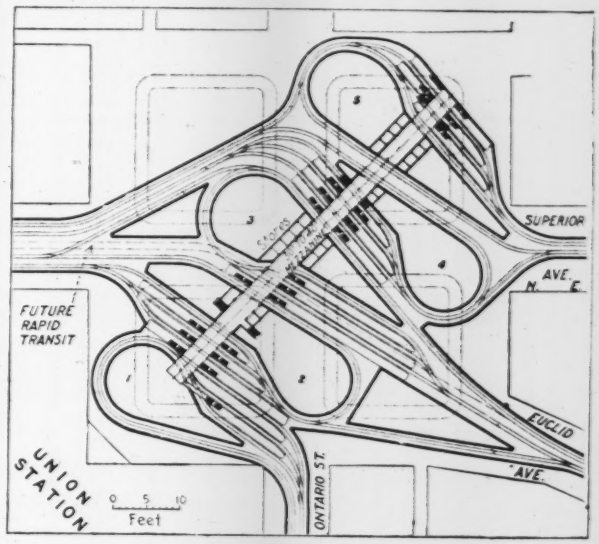


FIG. 2. TRACK ARRANGEMENT IN RECOMMENDED LOOP SUBWAYS UNDER PUBLIC SQUARE, CLEVELAND

tendency toward concentration of traffic at this point which must result from the union station, will make necessary some provision for underground looping of the surface cars in order to continue the present method of general transfer from line to line at this point." Discussing this matter further, they say that, "knowing that subways in the downtown district will require several years to build even for surface car loops, it is evident that a beginning of this work is now warranted. The extent to which this program should be enlarged and whether it should include initial rapid-transit lines at the present time is largely a financial question." On the basis of these considerations, and the fact that the radial arrangement of the city will make it impracticable to reach any large proportion of the outlying territory by a single rapid-transit line, the engineers proceed to develop the plan for improving the surface-car operations by placing the tracks underground in the central portion of the city.

For future rapid-transit development, they conclude that present conditions as well as probable future development indicate Euclid Ave. and Detroit Ave. as the obvious route for an east-and-west rapid-transit line. The scheme shown in Fig. 3 is therefore outlined, comprising a subway stem through Detroit and Euclid Aves., seven or eight miles long, with short lateral extensions, and thence outward elevated or open-cut lines in different radial directions.

Conclusions and Recommendations

The conclusions of the report are, in part:

The unification of street-car and rapid-transit lines into a single system is the most economical and efficient method of developing and operating a satisfactory transportation system for a large city such as Cleveland is destined to be.

The increasing congestion of vehicle and pedestrian traffic in the central part of Cleveland shows that the relief for street-car congestion must come from either looping back a large portion of the cars farther from the city's center or placing them underground in subways in this district, or combining both expedients. It does not appear that any further re-routing or rearrangement of the present surface-

car loops in the Public Square will be of benefit. These loops have in the rush hours practically reached their capacity. Relief for the present street car congestion can be secured by sections of subways built in progressive steps in such a manner as to become a part of through rapid-transit lines, when these latter can be financed.

Definite benefits beyond the improved service to passengers will be derived from the development of street-car and rapid-transit subways in the center of the city even before the main rapid-transit lines are developed. The time-saving will bring the outlying districts nearer the center of the city, and the added capacity for handling traffic in the central district will make possible the handling of passengers drawn from a greater residential area. All of these items tend to enhance real-estate values in all sections of the city.

An increase in speed of about 30% will be possible in the downtown district, by the use of the proposed subway loops in the Public Square and subway approaches. This will result in a saving of time for motormen and conductors, which at the present rate of wages and present car schedules shows a total saving of $112,000. Together with a saving in personal injury damages and track maintenance, this system of operation will save the interest of between $2,000,000 and $3,000,000.

The building of additional lines in the outer zone will be ineffective unless terminal capacity for handling their traffic is supplied in the delivery district at the center of the city.

In a radial city like Cleveland, with a predominating central business district, the congestion must be relieved at the center first and the extensions of the system carried outward.

The report recommends that subway loops, as shown by Figs. 1 and 2, be constructed as rapidly as the money for the work can be found. Effort should be made, it is stated, to provide further routes from the east to the west side by bridges and thus keep out of the central district the passengers who wish to cross the city and who can thus be kept out of the congestion. Vehicle thoroughfares should also be developed to facilitate similar diversion.

It is recommended that the loop subways be built in the following order: (1) Loops 2 and 4 with the subway section from the Detroit-Superior viaduct eastward to the Square, at a cost of $4,400,000; (2) the Euclid Ave. subway from 22nd St. to the Square, and loop No. 3, at a cost of $5,500,000; (3) the Ontario St. subway section and loop No. 1, at a cost of $3,500,000; (4) the East Superior Ave. subway section and loop No. 5, at a cost of $2,400,000. The cost figures are based on present prices of labor and materials.

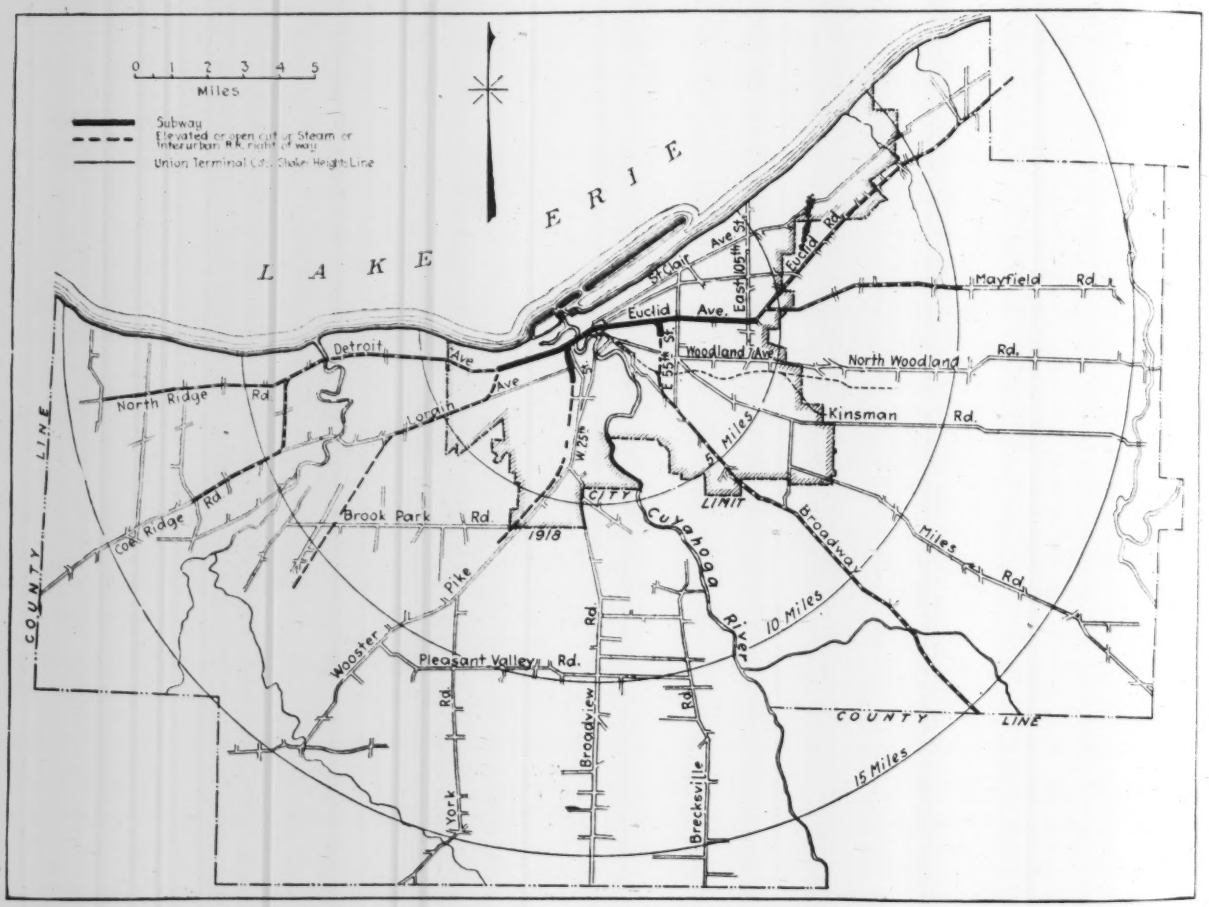


FIG. 3. SUGGESTED RAPID-TRANSIT SYSTEM FOR CLEVELAND

Construction of the rapid-transit system as such would be undertaken subsequently, the system shown in Fig. 3 being developed as rapidly as possible. "An estimate of the cost of such extensions has not been attempted as the character of the construction cannot now be determined."

Unification of all the transportation service in the

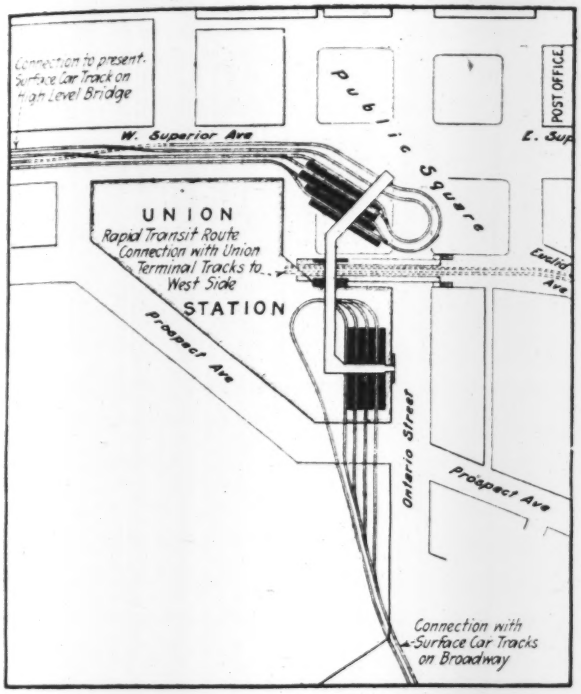


FIG. 4. ALTERNATIVE SUBWAY-LOOP SCHEME SUGGESTED AS CHEAPER THAN THAT SHOWN IN FIG. 2

city is made an essential recommendation fundamental to the entire report. The engineers also conclude that the street-car loops, as well as the rapid-transit system, should be coördinated with the new union station which it is planned to build at the southwest corner of the Public Square.

Seventy-Foot Concrete Flagpole Poured Erect in Place

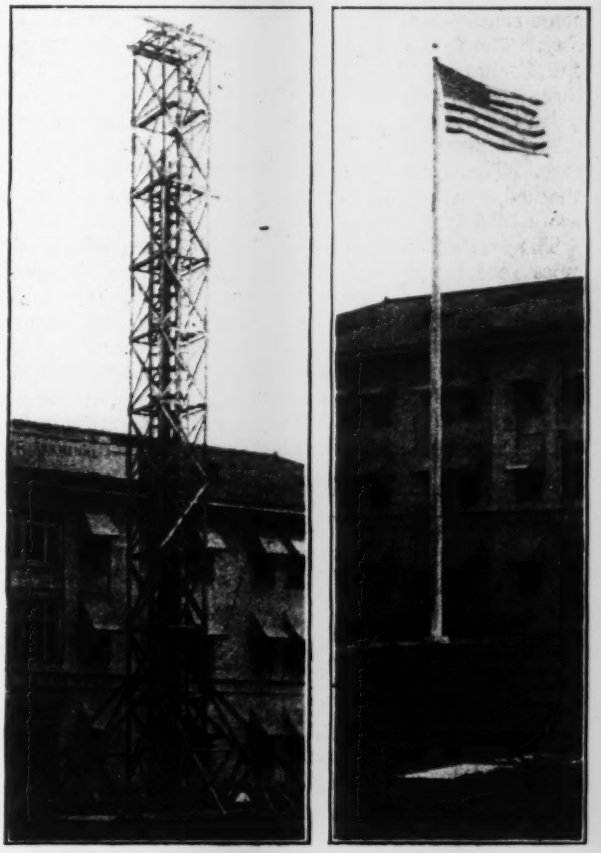
Method Saved Erection Equipment and Extra Reinforcement Required When Pole Is Lifted Into Position

BY R. C. HARDMAN
Acting Municipal Engineer, the Panama Canal, Balboa Heights, C. Z.

INABILITY to obtain a stick of the proper size and length, and the presence of a successful reinforced-concrete flagpole erected for the Panama Canal at Balboa Heights, a few years ago (described in *Engineering News* of Sept. 2, 1915, p. 452), determined the use of the same material for a pole erected in front of the new administration building of the Ancon Hospital Group at Ancon, C. Z. The earlier pole, which is of a rather elaborate design, was poured upon the ground in a horizontal position and later erected, necessitating complicated reinforcement to take the handling strains as well as strains after erection. As the cost of erecting was very high and the location of the proposed pole on a terrace rendered the method still more difficult and costly, it was decided to pour the pole in place. To this end a self-supporting pole was designed, stability being secured by an enlarged base which was extended into the ground 10 ft., the height of the pole above ground being 70 feet.

In design the pole is very simple, being 17 in. in diameter at the base and 8½ in. in diameter at the top, having, of course, the proper entasis at the intermediate sections. It is reinforced longitudinally with eight square bars decreasing in size from 1¼ in. at the base to ½ in. at the top and hooped with ⅜-in. square bars on 2- and 3-ft. centers. The ratio of steel to concrete at the base section is 0.055.

The construction of the pole was effected by means of a light tower similar to a hoisting tower. The forms for the pole, which were made of wood in eight sections, were erected inside this tower, to which they were securely fastened after having been plumbed by the use of two transits at right angles to each other. The forms were placed at the rate of but one 8-ft. section per day, but the steel was erected for the entire pole. The forms, being made in longitudinal halves, were thus easily placed about the steel and filled by means of buckets. The concrete mix used was 1 : 1½ : 3, the pole receiving in addition a float-finish coat immediately upon removal of the forms. No difficulty was encountered in the construction, although great care was necessary in the form erection to secure a creditable result. The pole proved to be so satisfactory, both



TOWER CARRYING FALSEWORK—CAST-IN-PLACE CONCRETE POLE

in cost and appearance, that a second one was soon erected, photographs of which are submitted showing the method of construction and the finished pole.

The pole was designed and built by the forces of the building division of the Panama Canal, Hartley Rowe, resident engineer. Arthur Hall, supervisor, had direct charge of the construction of both poles.

Backfilling Tunnel Through Holes Bored from Surface

Concrete Poured Around 60-Inch Cast-Iron Pipe in 10 x 10-Foot Rock Bore by Dropping It 70 Feet From Trestle Across River

By J. Armstrong
Division Engineer, Greater Winnipeg Water District, Winnipeg, Man.

OVER 1100 ft. of the new Winnipeg Aqueduct is in tunnel under the Red River, with the roof of the tunnel about 70 ft. below the high part of the ground and 40 ft. below the river level. The 60-in. cast-iron pipe carrying the water was concreted here into the 10 x 10-ft. tunnel by concrete dropped through holes bored at intervals from the surface.

The tunnel bore is through the solid limestone rock, the rock roof being some 17 ft. in thickness, with overlying soils of various clays, silts, and other river deposits. The rock was found to be fairly hard but badly seamed both horizontally and vertically and containing many pockets of varying size up to two or three cubic yards, evidently the result of water action at some remote period, but now filled with a white, chalky clay. The first 400 ft. of the tunnel from the eastern end discharged considerable water into the boring from these seams, although not in sufficient quantity to require the aid of compressed air, a 4-in. submerged centrifugal pump handling the water at all times with ease. The remaining 600 ft., although seamed and checked, seemed tighter, and comparatively little water was added from this portion.

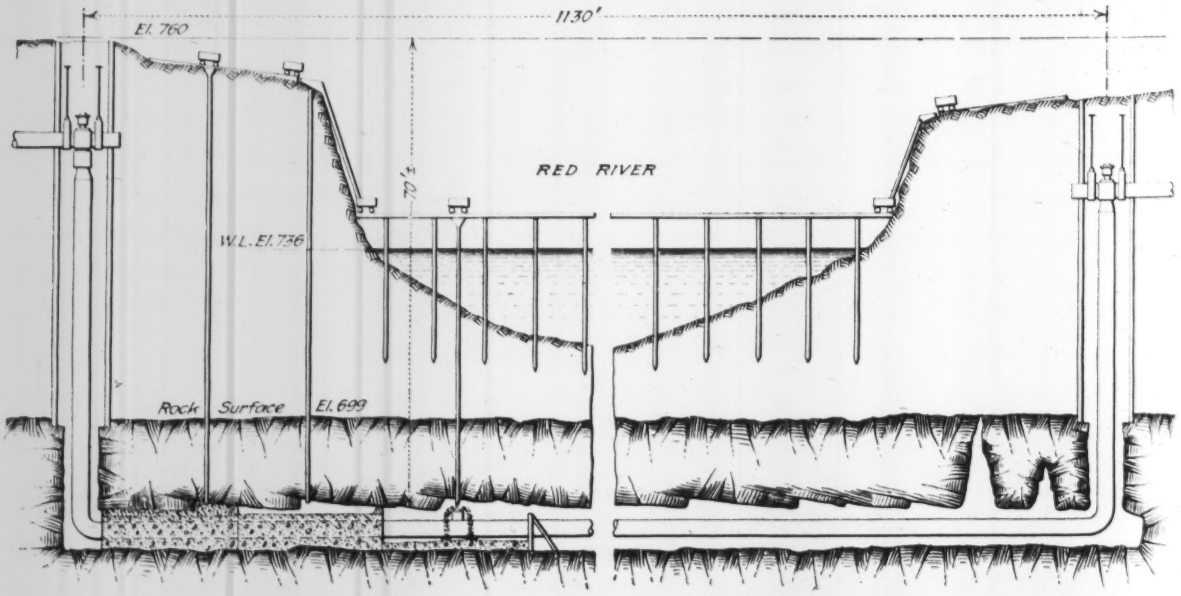
The original tunnel section was designed with a circular roof, but owing to the seamy condition discovered the section was changed to a 10 x 10-ft. square. The eastern shaft is some 2 ft. lower than the western shaft, to facilitate drainage during construction.

The water is conveyed through this tunnel in a 60-in. cast-iron lining. The contract required that after this lining was in place the remaining space in the tunnel bore be backfilled with concrete in such a manner as to guarantee an absolute filling of all irregularities and pockets. The specifications specifically prohibited the use of compressed air in placing the concrete. After much study the method adopted was by means of well holes bored from the surface through the roof of the tunnel. These holes were drilled with an ordinary well-drilling machine and lined with a 6-in. well casing from the surface to the rock. The spacing of the holes was somewhat irregular but averaged 40 ft., the holes being bored to this spacing at the nearest high spot in the tunnel roof.

For the river crossing a light trestle was built consisting of two-pile bents spaced 8 ft. centers with four longitudinal 8 x 8-in. stringers to act as bracing and to bear the light industrial track carrying the concrete cars. A mixing plant was provided at each end of the tunnel consisting of a ¾-yd. mixer, industrial tracks and concrete cars of various types.

The first operation consisted in the pouring of a concrete floor in the tunnel carefully graded to facilitate the placing of the 60-in. cast-iron lining. This concrete, some 250 yd., was all poured down one hole at the western end and distributed by cars using the same track previously employed in the tunnel excavation and later used to transport the cast-iron pipe.

When the lining was in place the tunnel was bulkheaded off in sections of various lengths and concrete poured until within 18 in. or 2 ft. of the roof. This was allowed to set and succeeding sections were poured. During the operation a concrete dam or bulkhead was built back on the set concrete, these dams being about 120 ft. apart, thus leaving three well holes between each two concrete bulkheads. After these concrete bulkheads were sufficiently hardened to withstand the pressure the final concrete was poured. The two end holes in each compartment were used to discharge the concrete, leaving the middle hole for observation purposes. In every instance when the end holes were filled the concrete rose in the middle or observation hole to the same level, showing a practically perfect hydrostatic action. As these holes provided a head of from 55 to 70 ft. of fluid



SECTION THROUGH RED RIVER TUNNEL OF WINNIPEG AQUEDUCT SHOWING METHOD OF CONCRETING PIPE

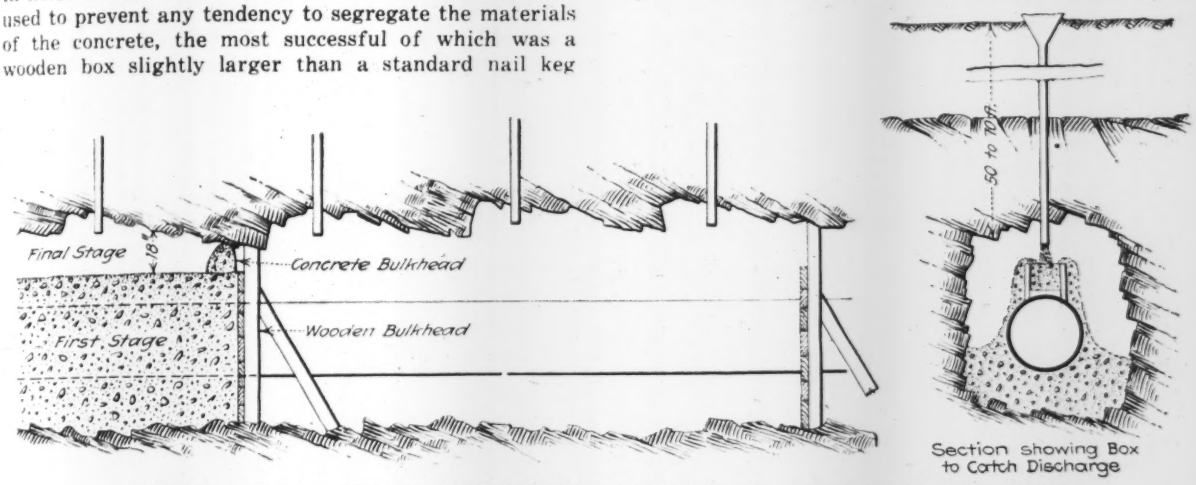
concrete there seems no doubt that all cavities and seams adjacent to the tunnel section must be completely filled.

For pouring the floor and the main tunnel concrete a mixture of 1 cement to 4 of aggregate was used, all stones passing a ½-in. ring. The stone was kept small to avoid a possibility of choking the pipes. A fairly wet mix was used although nothing approaching sloppiness was required. Observation indicates that aggregate containing stone as large as 1-in. might be safely used in holes of 5½- or 6-in. diameter. Various devices were used to prevent any tendency to segregate the materials of the concrete, the most successful of which was a wooden box slightly larger than a standard nail keg fixed on top of the cast-iron pipe and directly underneath the pipe. The force of the concrete discharging into this box full of concrete gave the constituents a very thorough remixing. As a further precaution an inspector and two workmen were kept in the section being concreted, and properly distributed the concrete. These men were able to work in the concrete until it was within 3 ft. of the roof and it was at this stage the concrete dam or bulkhead was built on previously set concrete preparatory to the final or grouting operation. These men usually sank half way to the knees in the concrete, which will give some idea of the wetness of the mixture. Spouts with a hopper swiveled under the holes were also used successfully but were awkward to handle and seemed to involve more extreme effort than collecting in the box and then working along by shovel and tramping. The inspector had a field telephone installed in the tunnel giving ready communication with the mixer when instructions were necessary.

The final stage was the filling of the space left as just described, the mixture used being 1 of cement to 3 of aggregate, the aggregate being in district parlance "rejected sand;" in other words, the excess finer materials screened from the pit run during the process of assembling the standard aggregate. This material was fairly well graded from a coarse sand to fine sand. As before indicated, this concrete was poured down the two outside holes of a three-hole set. A few batches quickly formed a cushion under the hole thus preventing segregation, as was easily proved by samples taken from the middle or observation hole.

The holes with one exception were bored directly on the center line. This exception was at the eastern end where the rock was exceptionally seamy, and a couple of bad caves resulted. The second one developed an opening completely through the rock, letting in a considerable flood of water and earth from above the rock. Fortunately, the hole was small and eventually became choked with stones and earth from above; not, however, before the caving was visible on the surface 70 ft. above.

Some hesitation was felt about driving a hole through this shaky roof, and fortunately one of the large water-worn cavities before mentioned was found here extending some 4 ft. off line of the tunnel. The pouring hole was accordingly driven here without the loosening of any further rock from the roof. Considerable water was coming through the roof in this section and was collected on a sheet-iron roof and run to wooden troughs along the side and carried beyond the concreting in progress.



SECTIONS SHOWING DETAILS OF CONCRETING AQUEDUCT BY DROPPING THROUGH PIPES

For the final stage of pouring at this section, a 2-in. pipe was run through the concrete bulkhead and extended upward to near the upper surface of the rock, some 12 or 14 ft. above the roof line of the tunnel. When ready for concreting the wooden troughs were plugged and the compartment allowed to fill with water. When this was completed the concrete was poured into the still water down the pipe. Shortly after commencing the concreting, water began to discharge through the 2-in. pipe leading through the bulkhead. Finally grout began to appear discoloring the water; then the pipe was closed. Concrete was poured into this hole until it finally appeared in the cave-in previously mentioned above the center of the tunnel.

Twenty-three holes in all were bored, the total cost of well boring, casings, temporary trestle over river and segregation prevention being less than $2.50 per cubic yard of concrete. Experience indicates that at least one-third of these holes might have been omitted. Where a 60-ft. head is obtainable the holes may be safely spaced at 80 ft. and with a certainty that all of the cavities will be thoroughly filled.

Municipal Ownership Extended at Berlin

Greater Berlin, Germany, acquired the street railway system known as the Metropolitan surface lines on June 26. The purchase price of 100,000,000 marks (or about $24,300,000 on the pre-war exchange basis) was paid in bonds.

Large Concrete-Cased Steel Pipe Laid in One Piece

Six-Foot Submarine Section 452 Feet Long, Built on Shore and Drawn Into Water—Special Methods Used in Launching

LAUNCHING and lowering to position in 26 ft. of water a 452-ft. inverted siphon of 6-ft. steel pipe, incased in 3 in. of wire-reinforced concrete, has been accomplished recently at the Passaic River crossing of the Jersey City water-supply. The pipe is not only of special design, but the methods used in moving it from the erection position on the shore to its position in the trench were also quite uncommon, it being necessary to make sure that there would be no cracking of the concrete casing during the operation. On account of

PIPE SECTION COMPLETED AND READY FOR LAUNCHING

the weight of the pipe, which averaged about one ton per foot, it was necessary to provide supports at short intervals for readjustment to relieve the strain caused by buoyancy and changes of grade as the pipe entered the water.

The water-supply for Jersey City comes from the Boonton reservoir some 20-odd miles from the city through a conduit which crosses beneath both the Passaic and Hackensack Rivers. The construction of the original crossings was described in *Engineering News* of Mar. 12, 1903, p. 232. In brief, the method followed was to erect the pipe on the shore, and, as it was erected, to drag it into the water by means of a hoisting engine on the far shore. The pipe, which was of 6-ft. riveted steel, was cased with precast concrete rings, which were slipped over as the riveted connections were made, the clearance space between the rings and the steel pipe being grouted with portland cement grout. The pipe was of $\frac{11}{16}$-in. steel plate, the concrete rings were 6 in. in thickness and the clearance space was about 2 in., making a total thickness of about 9 in. The concrete covering was not only for the protection of the pipe, but also to give sufficient weight to keep the pipe from floating when pumped out. A special conical-shaped bulkhead was used at the launching end. This method of procedure made it possible to lay the pipe without interfering in any way with navigation.

As a part of the work of duplicating portions of the original conduit, it was determined to lay another pipe of 72-in. inside diameter at each river crossing, on a line parallel to the other. Instead of casing the pipe with precast concrete rings, it was decided to cover it with concrete by the use of the cement gun, and to build the entire section on shore and launch it in one piece. The pipe is composed of $\frac{3}{8}$-in. steel plates riveted into sections at the shop, and taken to the site and erected. It was covered with heavy wire mesh, which may be seen at the end of the section in one of the photographs, and concreted as stated above. The plans called for a 3-in. layer of concrete with lugs to support precast concrete weights which were to be placed after the pipe was in position in the river. It was found, however, that it was impracticable to lay the pipe thus weighted at a depth sufficient to give the clearance required by the War Department for navigable rivers, so cast-iron blocks coated with asphaltum will be slung over the pipe at 16-ft. intervals. Each block will weigh $2\frac{1}{4}$ tons, the total weight suspended at each point being $4\frac{1}{2}$ tons. The section is constructed with a level portion in the bed of the river and goose-necks at each shore end.

To prepare the site for the construction and the bed of the river for reception of the pipe, a large trench was dug upon the shore, following the shore section of the pipe line, and extending down to the water's edge. The stream bed was excavated by a dragline excavator operated by a hoisting engine on the shore opposite the erection site.

For the shore launching ways, a narrow-gage track was laid in the bottom of the trench upon which ran small steel cars. These cars were placed at 20-ft. intervals, were lashed together with steel cables, and the steel pipe was blocked up on them and securely wedged as it was erected.

After applying the concrete to the steel pipe with the cement gun and allowing the finished sections to harden, the cars which supported the pipe were moved forward so that the points of original blocking might be covered with concrete.

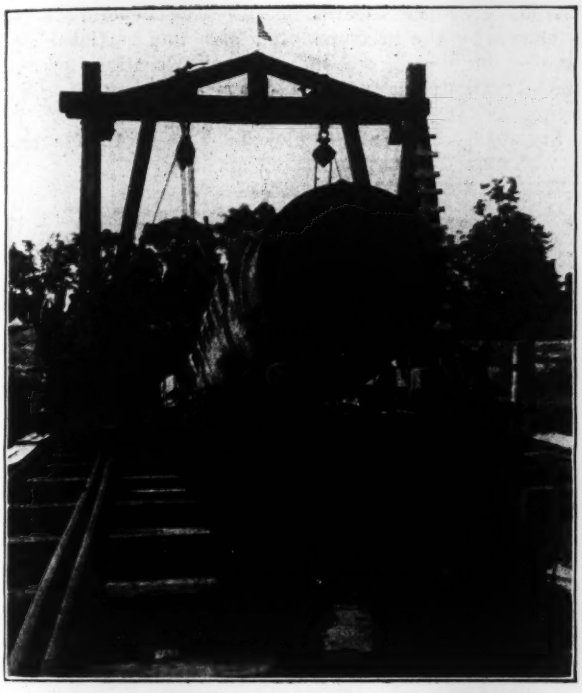
That there might be no strain which would damage the casing of the pipe, it was considered necessary to support it in the entire movement across the stream. To accomplish this a double line of 30-in. gage light railroad track was built on timber trestles, extending across the river, with 12-ft. clearance between the trestles, which paralleled both the shore and river trenches. Upon these tracks ran light railway cars at 25-ft. intervals, connected with steel cables. Blocked up on these cars and bridging from one trestle to the other were built up beams consisting of four 12 x 12-in.

TRESTLES WITH TRACKS AND ADJUSTMENT BRIDGES

timbers, upon which rested two crabs arranged to raise or lower the pipe as required. These beams were placed on the cars by means of a derrick. The tackle was attached as the pipe was moved into the water. After tightening up with the crabs, the cars below were lifted out with another derrick.

Propulsion was supplied by the same hoisting engine outfit which operated the dragline excavation bucket. A 24-part, ¾-in. line attached to two 1½-in. plow steel cables was used to draw the pipe. At each pull the pipe was moved from 12 to 15 ft., the whole train being kept taut by slacking off cables at the rear end.

Steep banks on each side of the river, giving abrupt changes in grade, combined with the effect of buoyancy as the pipe entered the water, made careful adjustments necessary. At each pull it was necessary to loosen or tighten all the crabs and rearrange the blocking to relieve the strain. A large derrick boat was used to help support the forward goose-neck, and two special trestle bents were used, one near the forward and one



LAUNCHING END OF PIPE, SHOWING BULKHEAD

near the rear end of the pipe. The pipe was given buoyancy by building an air-tight bulkhead in each end. Air and water holes were provided so that either an air pressure or filling with water could be resorted to when necessary, to raise or lower the pipe.

When the pipe reached position, it was sunk by the admission of water, and cofferdams were built at each end to connect it with the land line. The Government regulations require a clearance of 20 ft. between high tide and the top of the pipe. This method that was employed required the blocking of navigation for the time being.

The chief engineer in charge of the work is C. A. Van Keuren of Jersey City. The contract was originally let to O'Neil & Cutler of Jersey City, but they were unable to finish the job, and it was relet to Joseph L. Sigretto & Co., who have installed the pipe at the Passaic crossing and are working on the crossing of the Hackensack, which is upwards of 1000 ft. in length. J. H. Watson is engineer for the contractor and William Jones, who had charge of laying the other crossing 16 years ago, is superintendent.

Democracy or Partnership in Labor Management

BASED on a study at many industrial plants, the Working Conditions Service of the U. S. Department of Labor, Grant Hamilton, director general, has issued Circular No. 6, "Relations Between Employer and Employee," by Dr. William M. Leiserson, chief of the Division of Labor Administration.

The following extracts may induce readers who are interested to send to Washington for a copy of the entire circular.

Democracy or partnership in labor management requires an industrial relations organization designed to place the employees and the employer on an equality in bargaining power and to give them an equal voice in determining working conditions and terms of employment. Such an organization consists of employees' representatives, sometimes known as shop stewards or shop chairmen, employees' committees dealing with wages, hours, grievances and discharges, and an arbitration board of some kind to decide differences between the management and the employees. If the employer is not prepared to give his employees an equal voice in labor bargaining and shop government, he should avoid creating any committees or boards which give the appearance of collective bargaining but not the essence. Employees are quick to sense the difference in their daily experiences in the shop, and they think the employer is trying to deceive them.

The most advanced form of labor administration obtains in a few firms which have a vice-president in charge of labor, or a labor manager equal in rank and authority with the production, sales and financial managers. A large clothing concern, for example, divides its operations into five departments—purchasing, production, labor, sales and finance. At the head of each is a manager, and the five together constitute the executive organization of the business. No important policy is decided upon by any one department without its effects on the others being considered. If any policy is proposed in purchasing, production, or advertising, which may bring overwork for a period and then lay-offs, the labor manager is present to point out the effect on the workers in the plant and thus have the policy changed to prevent disorganization of the labor force. So it is with every other policy affecting labor. In such a plan as this the personnel organization and the industrial relations machinery are directed by the one labor manager. The handling of the personnel problems and the industrial relations are, however, organized separately.

Employers who deal with trade unions or who wish voluntarily to give their employees a voice in determining wages, hours, working conditions and shop government, have, in addition to the above, to operate the machinery for handling the economic or collective labor relations. Where an agreement is made with a union the methods of collective bargaining will be contained in the agreement. Where the employer wishes to inaugurate collective bargaining he will begin this by creating shop committees or an employee representation plan of some kind. Experience has shown that the best method of handling this is for the management not to devise some plan of its own but rather to ask the employees to elect representatives who, together with the management, will work out a plan approved by both. In this way the employees will not be as likely to criticise minor defects in the plan, for they will feel it is of their own making.

Steel and Concrete Framing Combined for Economy

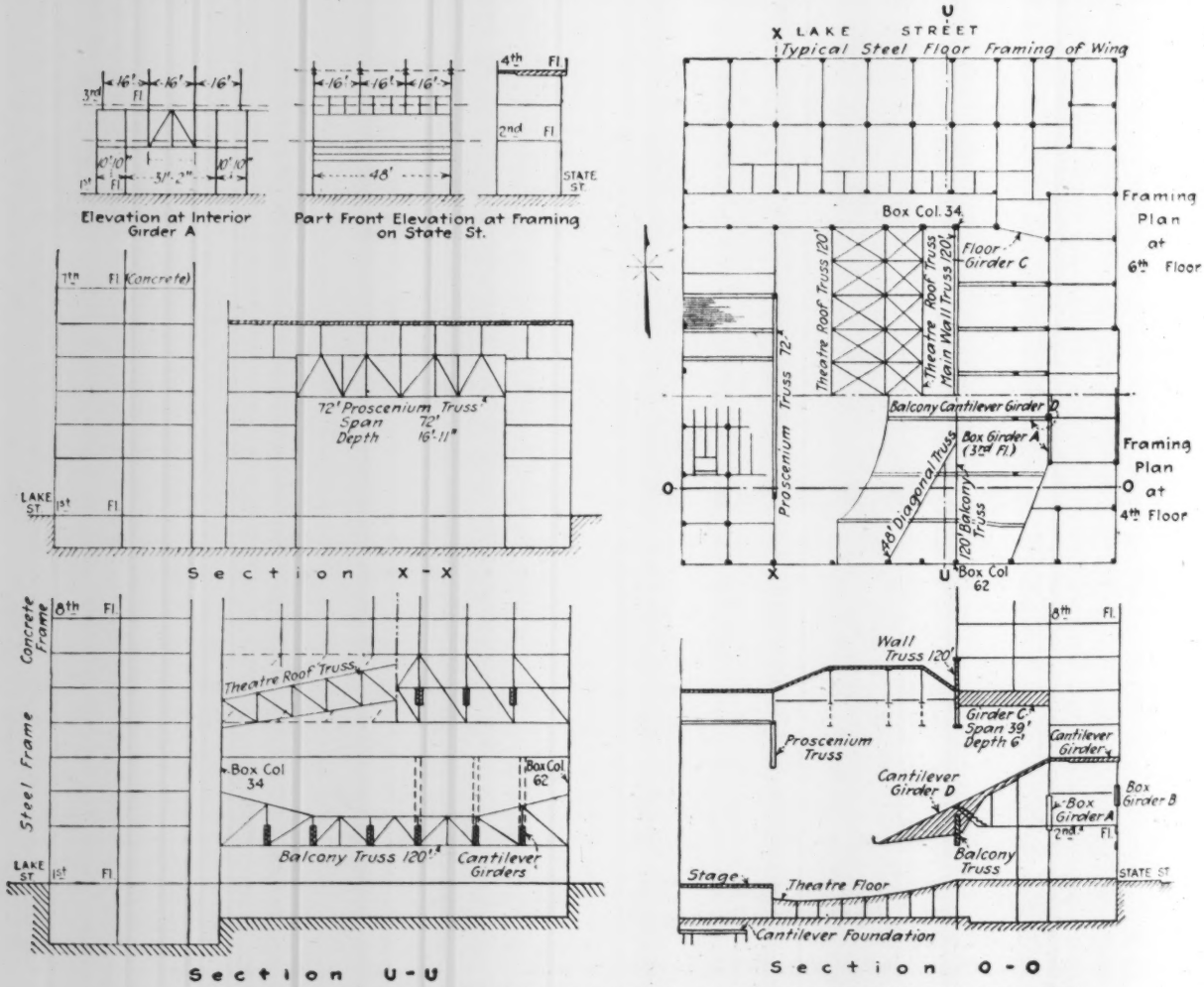
Cost and Space Both Saved in Chicago 12-Story Office Building Carried Over Theater Auditorium—Design Includes Special Heavy Trusses, Girders and Cantilevers

ELIMINATION of columns within the theater portion of a combined t eater and office building, and the combination of steel and concrete framing on account of the high price and limited supply of steel, are features in the 12-story State-Lake Building in Chicago. This building is an unusual case of structural design adapted to meet difficult conditions imposed by architectural requirements. With columns prohibited inside the large area of the theater floor, special truss and girder construction was introduced to support the upper floors over this area and also to carry cantilever supports of the large balcony within the theater. Girders in the office portion of the building provide for an unsymmetrical column layout, due to the different space requirements of the lower and upper floors. Cantilever girders support a projecting portion of the front wall and carry the rear wall at the property line.

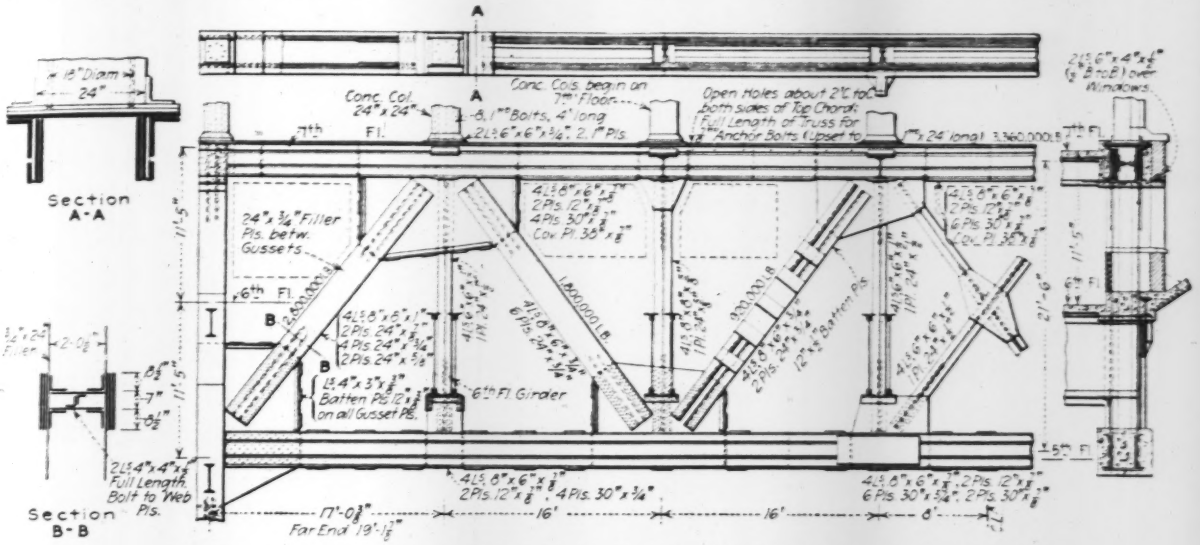
Steel is used for columns and framing of the first six floors, while concrete is employed in the six upper floors and roof. Concrete is the more economical material at present prices, but if used in the lower portion of the structure it would have necessitated columns of such large size as to be obstructive and undesirable. Furthermore, it would have been difficult to use concrete for some of the long spans required. By combining the two types of construction the advantage of steel is retained where this advantage is of importance. The total cost of the structural work was reduced about 10% by the use of concrete instead of steel for the upper portion.

On a site 180 x 168 ft., the theater, including the stage, occupies a space 163 x 130 ft., leaving a wing on each of the two street fronts. In the sixth and upper floors the building is of L shape, with a light court above the theater roof at the sixth floor level. The width of this portion is 65 ft. and 50 ft. on the State St. and Lake St. sides, respectively, and the wider wing extends over the theater space. The general design is shown by the accompanying plan and sectional elevations, on which are indicated the locations of the special structural features described below in more detail.

Six steel trusses are employed. Two of 120-ft. span


Elevation at Interior Girder A
Part Front Elevation at Framing on State St.
Section X-X
Typical Steel Floor Framing of Wing
Framing Plan at 6th Floor
Framing Plan at 4th Floor
Section U-U
Section O-O
DIAGRAM SHOWING SPECIAL STRUCTURAL FRAMING OF OFFICE BUILDING AND THEATER

and one of 75-ft. span carry heavy loads, while three of 120-ft. span support the theater roof. Avoidance of columns within the floor area of the theater is secured by the introduction of a riveted steel truss, 120 ft. between centers of columns, which spans this space and supports the columns in the west wall of the L-shaped upper structure. Its depth is 21½ ft. between centers of chords, which are at the fifth and seventh floor levels. Details are indicated in the drawing. This truss has a weight of about 170 tons and carries a total load of 2300 tons, which it transmits to a pair of heavy box columns between which it is framed. On the truss posts are angle brackets for the support of pairs of plate girders which form a part of the sixth floor framing.


Section A-A
Section B-B
Conc. Col. 24"x24"
Conc. Cols. begin on 7th Floor
Open Holes about 2" to Full Length of Truss for ¾" Anchor Bolts (Upset to
24"x ¾" Filler Pls. betw. Gussets
6th Fl.
7th Fl.
5th Fl.
6th Fl. Girder
Batten Pls.
Full Length Bolt to Web Pls.
Far End 19'-1½"

TWO-STORY STEEL TRUSS CARRIES WALL OVER THEATER IN CHICAGO BUILDING

The second 120-ft. truss is carried by the same columns, but at the lower elevation, and forms the fulcrum support for the concrete gallery cantilevers. While carried by the same columns it is not in the same vertical plane with the two-story truss above it. Thus, while one end is framed against the face of the column the other end is at the side of the column, so that the center lines of the two trusses are coincident at one end and 23 in. apart at the other end. The reason for this is that the lot is not exactly rectangular, and the balcony truss is at right angles to the axis of the theater, while the upper truss is parallel to the building line of State St. This truss is seated on auxiliary columns forming integral parts of the main columns. Owing to the unsymmetrical arrangement noted, this auxiliary support is on the face of one column and on the side of the other column.

Another feature in this balcony truss is the fact that its top chord is concave, the depth of truss being 18½ ft. at the ends and 12 ft. at the middle. This arrangement was required in order to keep the truss below the sloping floor of this balcony at the center and to allow for tunnel exits through the truss at the ends. It necessitates the use of heavy members in the middle panels.

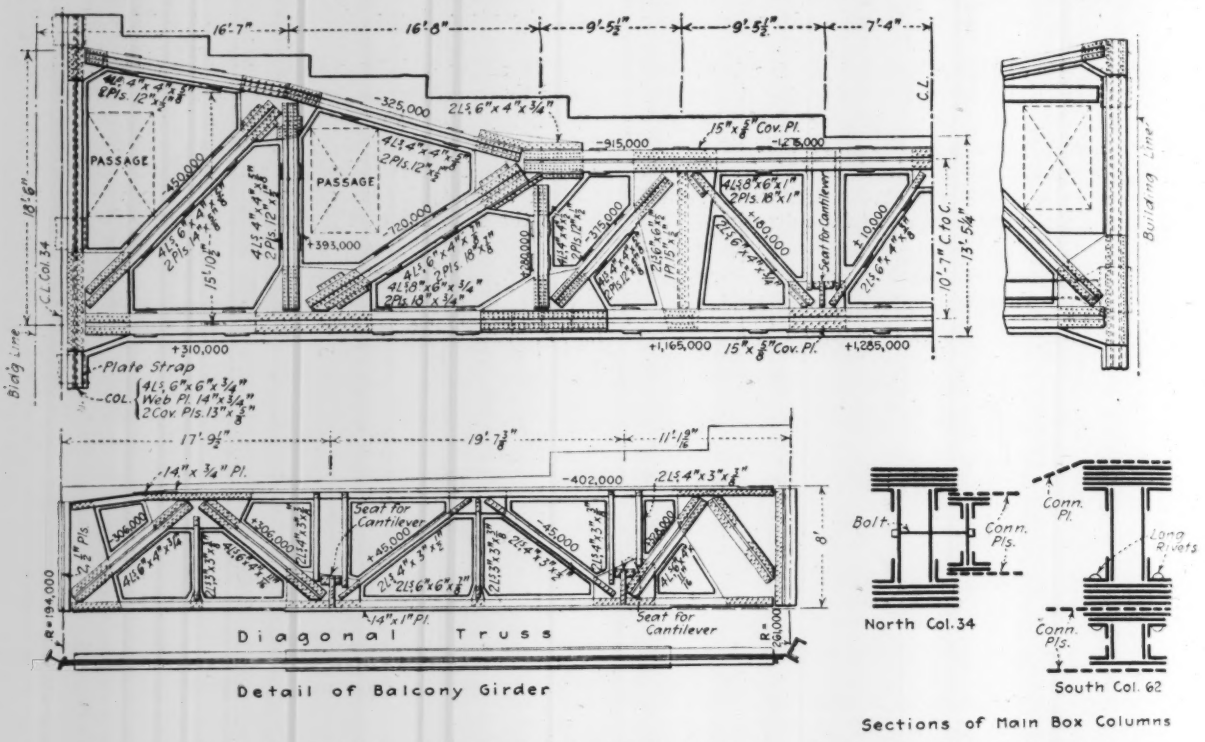
Owing to the curve of the balcony front, some of its supporting girders are so long that if seated in this truss their cantilever length would be excessive. To provide a fulcrum bearing in advance of the balcony truss, therefore, diagonal trusses 48 ft. long and 8 ft. deep frame into the balcony truss and into columns 28 ft. in advance. Entrance passages or corridors are carried through the end panels of the balcony truss.

Spanning the stage front is a truss having a length of 75 ft. and a depth of 17 ft. This carries no very great load. From the lower chord is hung the proscenium arch, which is of concrete. The top chord carries the framing of the fly gallery from which the scenery is handled. This consists of pairs of 12-in. channels resting on the wall girder and the truss, while between and parallel with these are 3-in. I-beams spaced 5½ in. on centers. The truss also carries a row of columns supporting the roof over the stage and that over the theater.

The cantilever girders carrying the gallery are of concrete instead of steel, for the reason that this construction was cheaper and obviated the necessity for complicated structural details where the cantilevers pass through the balcony truss. They are inclined to conform to the slope of the balcony floor and have their upper ends at the fourth floor level. The length of the girders varies from 26 ft. for the middle girders to 28 ft. for the side girders, with cantilever lengths of 12 ft. and 10 ft., respectively. The fulcrum bearings are on seats in the 120-ft. balcony truss and its auxiliary diagonal trusses, as described above. These six cantilever girders are 18 in. wide, 2 ft. deep at the upper portion and 9 ft. deep over the fulcrum supports. Between them is the concrete slab forming the floor of the gallery and serving as lateral bracing between the girders, and stepped to form benches for the seats. The entire balcony, including girders and slab, was poured in one continuous operation.

A 48-ft. box plate girder, 12 ft. 8½ in. deep, with an open middle panel, provides for changes in column arrangement. Thus, it is supported by four columns forming a central space of 31 ft. 2 in. for the main entrance to the theater floor, and two side spaces of 10 ft. 10 in. Upon it are supported four other columns spaced 16 ft. on centers.

The open 16-ft. middle panel, in which truss members are used instead of web plates, was adopted in order



120-FOOT AND DIAGONAL TRUSSES WHICH SUPPORT CANTILEVER GIRDERS OF BALCONY

to reduce weight of steel, as there are no shearing stresses in this portion, except for unsymmetrical loading. No web stiffeners are used between panel points, but the deep webs are connected by ⅞-in. tie bolts and by filling the space between them with concrete. The webs are of ½-in. plates, 14 in. apart.

The 65-ft. width of the upper portion of the State St. side of the building extends over the area occupied by the theater and has to be carried above the balcony floor without the support of intermediate columns. At the sixth floor level, therefore, there are steel girders of 39-ft. span, each consisting of a pair of 6-ft. plate girders having their inner ends framed against interior columns of the building, while their outer ends rest on brackets on the posts of the main 120-ft. truss which carries the rear wall of the wing. Upon each of these girders is seated an intermediate column which carries the framing of the upper floors. The girders are designed for a uniform load of 6000 lb. per foot, and the loads which the intermediate columns transmit to them vary from 360,000 to 405,000 pounds.

The two columns which carry the superimposed balcony truss and wall truss of 120-ft. span are of special section. The north column where the two trusses are in the same plane has the added supporting area on the inner web or face of the main column. It is of I-section, with its web parallel to the main web and its flanges inside those of the latter. Through bolts 2 ft. apart connect the three webs. The south column, where the two trusses are not in the same plane, has this added area on the side. It is of box section similar to the main part of the column, but smaller, and long rivets pass through the cover plate and flange angles of both portions.

Box columns carry the 75-ft. proscenium truss and the two 48-ft. girders in the front and interior framing. Most of the other steel columns are 14-in. and 12-in. H-beams, some of which, with long, unbraced lengths, are reinforced by cover plates on the flanges. In the side portions flanking the stage, used for dressing rooms and other theatrical purposes, some of the taller columns are 24-in. I-beams.

Steel floor framing is mainly of I-beams, with girders at certain points carrying a concrete floor of the slab-and-joist type. Steel joists and a flat slab are used for the stage, owing to the number of openings or traps required. The theater floor has a concrete slab, inclined to the proper slope and stepped to form benches for the seats. Floor loads were specified as 100 lb. per square foot for the main theater floor, the stage and the balcony, with 50 lb. for the upper or office floors.

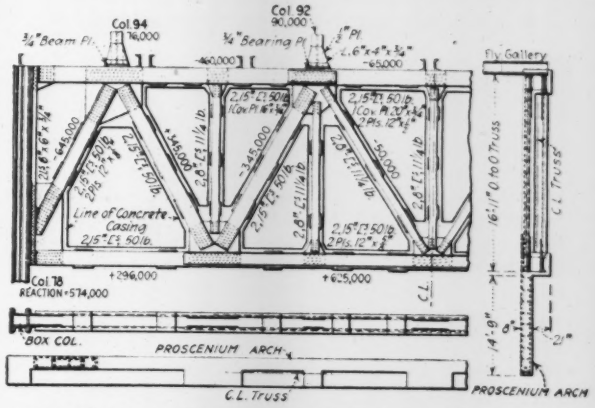
Steel columns terminate mainly about 3½ ft. below the seventh floor, which is the first concrete floor, but some extend to this latter level. They carry shoes for the bases of the superimposed concrete columns. Above the shoes, the columns have short bolts through the web and flanges, in order to form a bond with the concrete columns built around them. In certain columns, also, the flanges are cut or notched for the same purpose.

Concrete columns are rectangular in section, from 23 to 28 in. square at the base, in the sixth floor, although two are 30 in. square. Some extend above the main roof to carry the attic floor and pent-house, but all are 20 in. square at the top. The reinforcement consists of vertical deformed rods and steel spirals, except that ties instead of spirals are used in some cases. The concrete is a 1 : 1 : 2 mix from the sixth to the ninth floor, above which it is 1 : 2 : 4. Four columns at one corner of the wing extend above the attic floor and support four girders with a 6-in. slab for a 30,000-gal. wood tank. Columns supporting the beams of the theater floor are mainly 14 x 14 in., with 2-in. beveled corners.

Typical concrete framing for the six upper floors consists of wall girders or lintels with girders across the 50-ft. and 65-ft. widths of this L-shaped part of the building. No interior girders parallel with the walls are used, as the floor slabs are sufficient to carry the loads and serve as interior bracing. The floors are 6 in. thick, with girders 29 to 31 in. deep, including the slab. Wind bracing is provided by special reinforcement in the girders. At the seventh floor, where some of the steel columns extend above the concrete beams, the latter rest on shelf angles and are anchored horizontally by three rows of anchor rods 10 ft. long which extend through the columns.

Over the theater area is a concrete slab roof at about the sixth floor level, carried by three 120-ft. trusses. Purlins of pairs of 6-in. channels extend across these, the outer ends of the purlins being carried by the 120-ft. wall truss and the 75-ft. proscenium truss. Between the bottom chords are framed 7-in. I-beams from which the frame for the ornamental ceiling is suspended by hanger rods. This frame consists mainly of light angles. Electric lamps for decorative indirect lighting are arranged in recesses in the ceiling, and the frame is laid out with gangways to permit men to walk over the ceiling and replace lamps from the inside. Flat-slab concrete roofs cover the office and stage portions of the building.

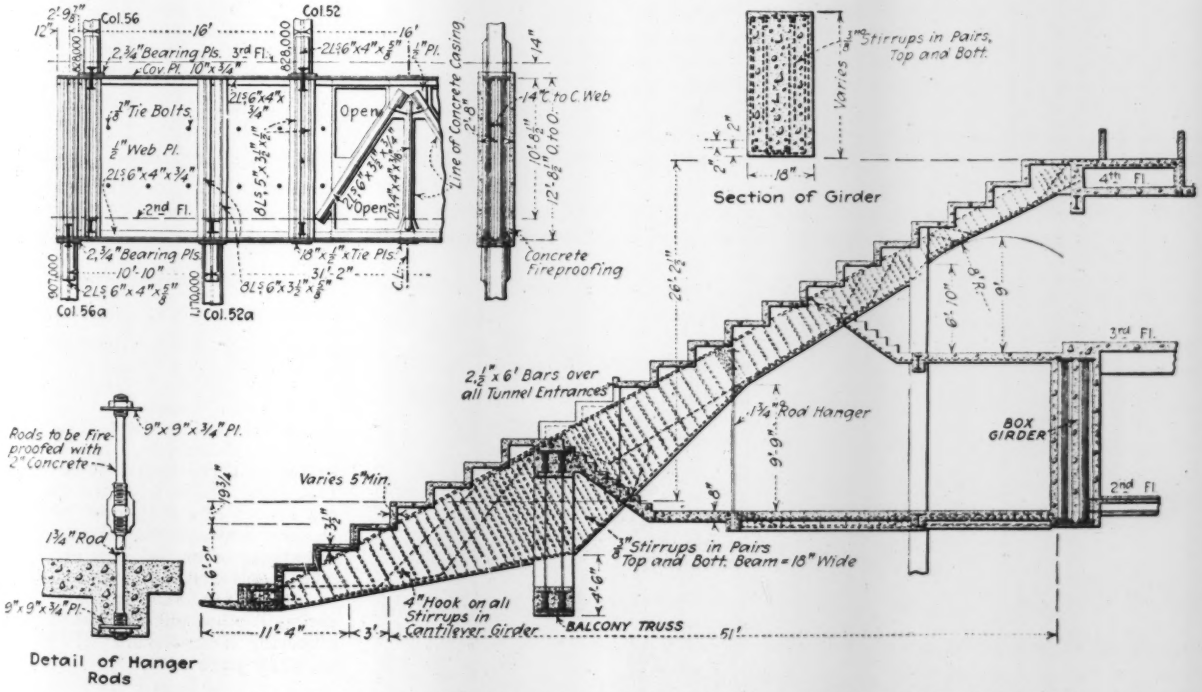
Concrete pier foundations are employed, most of the piers being carried down to hardpan at about 87 ft. below street grade. These have the base belled out to twice the diameter of the shaft. Five piers are carried down to solid rock at 123 ft. below street grade, and these are not belled out. Two of them are 7½-ft. piers, made of 1 : 1 : 2 concrete, for the box columns which carry the two 120-ft. trusses of the balcony and rear wall. Each of these columns has a load of about 2000 tons on the pier.



TRUSS SPANNING STAGE CARRIES PROSCENIUM ARCH AND WORKING FLOOR

Other piers carried to rock are for a portion of the rear wall in which the columns are carried by cantilever girders in order to keep the piers within the property line. These girders are pairs of 30-in. I-beams, resting on a grillage of 12-in. I-beams in the head of the pier. Concrete cantilever girders are used to support other columns in the rear wall, and some of these carry intermediate columns. Concrete footings in firm clay support the short columns of the theater floor.

Large members could not be handled within the building, owing to the numerous columns and to the difficulty of unloading in the street. Therefore the trusses were built up on the site, and large connection plates on the columns were placed in the same way. The 75-ft. truss was assembled at the basement level about 5 ft. forward of its position. It was then raised by derricks until the projecting ends of the bottom chords and end posts came between the connection plates on the columns.



CONCRETE CANTILEVER GIRDERS AND BOX-PLATE GIRDER WITH OPEN MIDDLE PANEL

and held by bolts and drifts while the rivets were driven.

The balcony truss was built up in three sections, the deep end portion in the basement and the shallow central portion on falsework at the final elevation. The derricks then raised the end portions, and they were bolted temporarily to the columns and the central portion while the connections were riveted. All steel work is cased in concrete fireproofing.

Lieberman, Klein & Hein were consulting engineers and prepared the structural design to conform to the plans of C. W. & G. L. Rapp and G. A. Lansburgh, associated architects. The Longacre Construction Co. is the contractor.

The Changed Dollar and the Engineer

THE report of the committee on the classification and compensation of engineers organized by Engineering Council, abstracted in *Engineering News-Record* of June 19, 1919, p. 1198, showed by the record of average prices of staple commodities compiled for many years by R. G. Dun & Co. that the purchasing power of a dollar in 1918 was only about one-third what it was in 1897. In one of the Government departments in Washington a committee of engineers is investigating the high cost of living with the aid of the most reliable statistics available.

This committee has plotted the chart shown in Fig. 1 with the idea of presenting the best and most accurate record available of the changes in the value of the dollar which have taken place in Washington since 1890. The sources are given on the chart, the part A being made up to show the cost of various items. The curve has been compared with a curve obtained by plotting the index numbers of R. G. Dun & Co.'s statistics used by the committee referred to above. In the period from 1900 to 1916 this curve varies nowhere more than five points from the curve made from Dun's index numbers. In the period from 1917 to 1919 the curve shown in the diagram is lower than the Dun curve as much as 30 points in some places. In this period, however, as the curve is taken from actual prices in Washington, it is without doubt more reliable for conditions there than are the figures given by Dun & Co., which represent wholesale prices at market centers.

It will be seen from the broken line in Fig. 1 that while the increase in the union rate of wages for the

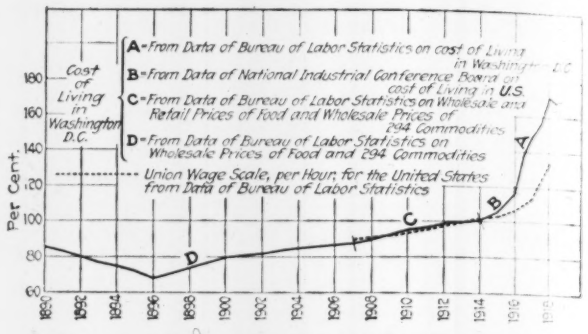


FIG. 1. CHANGES IN THE COST OF LIVING IN WASHINGTON, D. C., SINCE 1890

seven years from 1907 to 1914 just about kept pace with the advance in the cost of living, it has fallen far below it in the five years since the outbreak of the war.

According to the figures, the resident in Washington, D. C., finds today that a dollar will only buy what could have been bought for 57 cents in 1910. Fig. 2 show the condition of an engineer in the Government service who had a salary of $2,000 a year in 1910, and who has received successive increases up to $3,300 since last July. The dotted line shows that since Jan. 1, 1915, the buying power of his salary has been falling off to such an extent that his salary since April, 1917, or

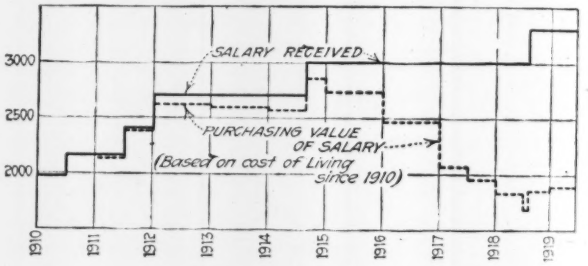
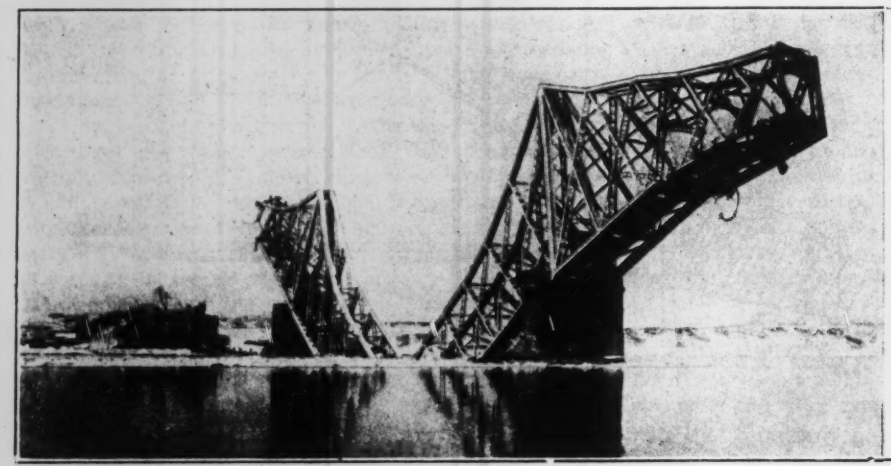


FIG. 2. ILLUSTRATING WHAT HAPPENED TO A GOVERNMENT ENGINEER NOTWITHSTANDING SALARY INCREASE

shortly after the United States entered the war, notwithstanding its increase of over one-third, bought less of the necessaries of life than did the salary of $2,000 which he received nine years ago.



Rumanian Bridge Wrecked During War

How the Rumanian Army during retreat in 1917 delayed advance of enemy—Cantilever bridge of three equal 140-meter (459-foot) spans over the Borcea branch of the Danube River on line between Bucharest and Constanta—One of the structures mentioned in announcement of desire for American aid in reconstruction, published in "Engineering News-Record" of June 26, 1919, page 1281.

"Case System," Changes in Engineering Curricula, and Business Training for Engineers

Results at Army Engineer School at Camp A. A. Humphreys in Applying Definite-Problem Method —Radical Reorganization in Methods of Instruction Effected at Tufts College and Yale University

Some of the most interesting developments reported and discussed at the recent meeting of the Society for the Promotion of Engineering Education in Baltimore are indicated in the following abstracts of papers there presented. Owing to insufficient time for presenting details at the Baltimore meeting, there is also included here a statement subsequently prepared by Major More and Captain Duckering, of the Army Engineer School at Camp A. A. Humphreys, Virginia, describing in brief the nature of the work there accomplished in applying the definite or concrete problem method to the teaching of engineering mechanics. The radical changes in the engineering curricula at Tufts College and the Sheffield Scientific School, Yale University, are described by Dean Anthony and Professor Tracy, respectively, and the modifications at the Kansas State Agricultural College are given by Dean Potter. In addition, there is included an abstract of Dean Marston's address delivered at the Washington conference of June 23-24 on the subject of business training for engineers.—EDITOR.

"Case System" for the Study of Law

BY C. F. ALLEN
West Roxbury, Mass.

IT WILL first be necessary to understand what is meant by the term "law." The study of law is essentially the study of the common law, so-called. The basis of the common law is right and justice, and in business matters custom often determines what is right and just. Thus, when individuals differred as to rights, courts were resorted to for the purpose of securing an unprejudiced decision. The decisions thus rendered are found in the "cases" reported, and it is customary now to print and bind the reports of cases decided, so that they may be available to lawyers for use in court trials. The decisions thus recorded become the law and the common law rests upon these decisions, and the principles fixed may be derived from the study and comparison of them.

When Professor Langdell was appointed dean of the Harvard Law School in 1870, the course covered one year and a half of work, the instruction was largely by lectures, and there were no examinations. No wonder that he saw the need for something better!

Engineering colleges have found that theory can be taught to the best advantage only in connection with its applications. In the "case system," the pupil studies the cases, and his duty is to discover the principle or rule of law which will be directly associated with the facts. The theory and its application are here brought together. Langdell evidently appreciated the fact that a qualitative understanding of law is more important than a quantitative knowledge of law.

Another feature of the instruction, which may more properly be called Langdell's system, appears to the writer to lie at the root of the success of the "case system" at the Harvard Law School. Quoting Langdell: "It was necessary, first, that the efforts of the students should go hand in hand with mine . . . , secondly, that the study thus required of them should be of the kind from which they might reap the greatest and most lasting benefits; thirdly, the instruction should be of such character that pupils might at least derive greater advantage from attending it than from devoting the time to private study." Again, "I wish to emphasize the fact that a teacher of law should be a person who accompanies his pupils on a road which is new to them, but with which he is well acquainted from often having traveled it before."

The system of instruction adopted was neither lecture nor recitation, but a well considered conference or discussion into which the teacher and the pupil entered on substantially even terms. The teacher assumed the position of leader rather than instructor, all working together in research, seeking for the truth, groping for the truth more often, perhaps, and floundering not a little. The teacher subordinated himself, helping rather than directing. The instrument was a corkscrew rather than a ramrod, and yet not the stomach pump of the recitation. In the Harvard or Columbia law schools, classes of 100 to 150 students engage in this intensive intellectual work. Digressions from the theme are as a rule dismissed by the lecturer with a short remark; if the professor notices a general lack of understanding of the case, he interposes with a lengthy explanation.

With a treatise or a textbook as a basis, it is almost as natural for a pupil to depend upon memory as it is for a fish to swim. With the system of conference and discussion the pupil is called upon to think, to reason, and at short notice, and with the case book as a basis, to reason legally. The thinking and reasoning are in the classroom and memory cannot be substituted. Langdell delayed putting into force his scheme for teaching for a year and a half until he found time to prepare his case. In the medical school, case books are already prepared. In the military school a book of problems was in effect a case book. Will a case system be impossible in an engineering college without a case book? Who will prepare one?

The Problem Method at the Army Engineer School, Camp A. A. Humphreys

BY MAJ. C. C. MORE, AND CAPT. W. E. DUCKERING
United States Army Engineer School, Camp A. A. Humphreys, Virginia

THE primary purpose of the Engineer School at Camp A. A. Humphreys, Virginia, is to stimulate and encourage the student in the exercise of his power of independent thought, reasoning and judgment, and to increase his ability to cope with new situations when confronted with them in engineering practice, rather than merely to provide him with a fund of engineering information and abstract theory, valuable as the latter are as adjuncts in his training. This purpose was laid down as a guiding principle at the very beginning by the Chief of Engineers, Maj. Gen. William M. Black, and was emphasized continually by Col. V. L. Peterson, commandant of the Engineer School. Under the

personal direction of Col. Earl North and with the enthusiastic coöperation of the instructors, this object was attained in the half-year which ended June, 1919, in the department of mechanics of engineering by the use of methods similar to those which have been in successful operation during the past six or seven years at the University of Washington, Seattle.

The major portion of the classroom work was devoted to stimulating mental effort on the part of the student, and to training him in practical methods of attacking, analyzing and solving engineering problems, instead of being devoted to the usual methods which attempt to cover a set amount of textbook material. The student was encouraged to use his own judgment and to make use of ideas which had grown out of his own previous experience. An endeavor was made to lay the foundation for future effort within the student himself, rather than in a text which he could carry under his arm. Every encouragement was offered to the development of what may be called the "engineering mind."

In this method there are two definite phases of the work: First, the phase in which study problems are used, and, second, that in which drill or training problems are used.

Study problems were designed for the purpose of analysis rather than synthesis, with concrete engineering situations used as a basis. Where feasible, the objective ideas corresponding to technical terms used by engineers were presented by means of visits to actual engineering structures. In this manner the students were enabled more easily to visualize and understand the technical language of the engineer.

Principles of Engineering Thought Introduced

For example, a bridge was visited before the first study problem was taken up. The names and functions of the various parts were discussed, and the question was raised as to the path traversed by a load placed upon the bridge, as transmitted through the members of the bridge from its point of application to the ground. This introduced one of the fundamental principles of engineering thought into the minds of the students at an early stage in their training. This visit to the bridge was not made for the purpose of analyzing that particular structure but to introduce the subject of structures in general. The subsequent classroom work dealt with a different type of bridge, and during the course many types of bridges were used in problems, so that the student would not be limited, in his idea of bridges in general, by the one that he happened to inspect first.

In the classroom, the first definite study problem dealt with a pony-truss span, for which were furnished the usual engineering detail drawings showing all dimensions and sections. Military necessity required that a certain heavy howitzer be taken across the bridge. The question was asked: "Is the bridge, in its present condition, safe for this load? Report." With the situation before them, the students were turned loose upon the analysis of the problem. The next step, following naturally from the discussion held at the bridge site when inspecting the structure in the field, was to determine how the structure might fail. Each student was required to use his own ideas and make a list of possible sources of failure.

These lists were then taken up for general discussion, and from this as a starting point the students were led step by step to investigate the various members of the structure. The necessary theoretical analysis was introduced whenever required. The hanger and both chords had purposely been designed too light, thus adding an element of interest to the search for possibilities of failure. When the students discovered these members to be unsafe, they were asked to redesign them in accordance with standard specifications.

Naturally, some phases of the analysis seemed too intricate for immediate treatment in the class; but these were easily deferred. For instance, in the case of the floor system, the investigation was carried to the point where the worst positions of the load were decided upon, and sketches were made showing the probable manner in which the planks, stringers and floor-beams would break, but the determination of the actual fiber stresses in these members was deferred temporarily with the understanding that it would be gone into carefully in subsequent discussions. However, the class was led to make recommendations concerning means of strengthening these parts of the bridge in case they were found to be unsafe.

Importance of Assumptions

At every step in the analysis of study problems, the many possible assumptions underlying the mathematical computations were always discussed at length by the class, and often two or more assumptions were taken as a basis for mathematical analysis before the students were encouraged to make final judgment concerning what appeared to be in line with the best practice. In this manner the student is made to realize that engineering is not an exact science, that the element of judgment plays a very important part in all engineering problems. He also starts his career with a more open mind and a greater capacity for making advances along new lines of engineering thought. He develops a keen interest in engineering literature, especially current engineering periodicals and papers and discussions of engineering societies. Students are not subject to the limitations of a single text, but find it advantageous to refer to several. An inevitable result of this kind of training is the tendency of the student to rely more and more on his own judgment with respect to making assumptions, and in all his work the student shows a greater self-reliance and an increasing desire to do independent thinking.

The chief purposes of the drill problems are to furnish vehicles for training, and for fixing the use and understanding of the fundamental principles firmly in the mind of the student by well directed repetition. Practically all review work had these purposes in view, though it was possible to use these problems as a means of grading the students and of giving them their section rating. The purpose of these problems, held before the mind of the student, is the opportunity to set up good habits of analysis and of work, and to increase, by means of carefully organized and well executed computations and sketches, his power to get accurate results and develop speed, while at the same time each problem makes him more at home in the use of the necessary mathematics and mechanics.

In order to aid in the accomplishment of these purposes, the major problems were broken up into a large number of subproblems so that the arithmetic might be made easy and so that particular attention

might be directed to a great variety of special uses of the fundamental principles. To help the student organize his work with a view to the development of speed and accuracy in execution, and as an aid to clearness of thought, he was required to work in accordance with a definite set of specifications covering the means whereby system, clearness and accuracy may be attained. He was taught to recognize the importance of each step in the solution, as a link in the chain leading to a final result, and to surround his computations with as many safeguards and checks as necessity demanded and time permitted. The result of this training in the mechanical side of analysis was to increase tremendously the accuracy of the work. The student found himself not only getting more definite results but he also developed the power to find and correct his own errors. All this tended to increase his pride in his work and to give him confidence in himself; while at the same time he was forming good habits of thought and work which would be transferred to his engineering practice later on. In short, the classroom work was made to approximate actual engineering experience as closely as possible.

The results obtained make it clear that a system of instruction designed along the lines sketched above does decidedly awaken and hold the interest of the student in the live problems of the engineering world. It does increase the confidence with which the student tackles a problem and stimulates his self-reliance and initiative. At the same time he shows greatly increased industry and speed of learning. This is further accentuated by the fact that no grading is done on study-problem work. The student is left free to take chances in doing independent thinking. The grading for purpose of classification in sections is based entirely upon work done on drill problems. The student is given to understand, however, that the only grades which affect his final passing in the course are those determined in the last four or five weeks of work, when nothing but review problems are taken up. His desire to work for passing marks becomes secondary and is dwarfed by his desire to understand engineering theory in order that he can use it in his work. His career as an engineer has begun.

Tufts College Changes and Their Results

By Gardner C. Anthony
Dean, Engineering Department, Tufts College, Massachusetts

THE sudden departure from the generally accepted curricula of engineering schools which was made at Tufts College last January was not hastily entered into, but in reality was the product of five years of investigation, study and experimenting. This was largely stimulated by the discovery of the apparently universal lowering of scholastic standards during the sophomore year; it appeared that some of the intellectual depreciation was chargeable to the curriculum. The freshman program, rich in fundamentals, failed to inspire because the student was not given the opportunity to orient himself early in his course by direct contact with the applied field of engineering.

As a result of study by several faculty committees in 1913-1914 the following recommendations were made: (1) A reduction in the number of subjects pursued at one time; (2) a closer coördination of the several departments, and consideration of a single course in engineering for three years, with opportunity for specialization in the fourth year; (3) the introduction of engineering subjects earlier in the course; (4) the necessity for closer correlation of theory and practice, together with an inversion of the usual order by introducing laboratory practice previous to the consideration of much theory.

After the upheaval due to the S. A. T. C., the psychological moment for the inauguration of the new course seemed to have come. The ideas aimed at were:

1. To present a survey of a chosen field of engineering previous to a detailed study of fundamentals.
2. To coördinate theory and practice by using projects of a distinctively engineering character involving theory.
3. To reduce the number of subjects studied at one time while intensifying the work done in those subjects.
4. To rate the student by observations on his character as well as by the quality and quantity of his prescribed course.

The most important feature of the new curriculum is the main introductory course conducted on the project plan. For example, in civil engineering the first two projects are the study of two garages, one of wood and one of steel, for which the first students had to meet the following requirements:

Make sketches and measurements of the building; make ¼-in. scale drawings showing plans, sections and elevations; estimate the material; study the structure with respect to the following: Computation of loads on members, discussion of materials used and their suitability, laboratory tests on beams, and consideration of the strength of beams.

The third project was a small highway bridge, and the fourth project was a preliminary layout and survey for an underground tunnel for a central heating plant. These four projects comprise the year's work for the freshmen, with three laboratory periods and three recitation periods per week.

Results of the New Course

The methods used in the introductory course may appear superficial and suggestive of a smattering of professionalism in catering to student interest only, but the results prove the error of this supposition. Interest, enthusiasm and keen desire for the more advanced theoretical work is produced in the eager and receptive mind of the freshman. An increase in observation is one of the noticeable products of the training. Of course, it is heresy to talk about moments of inertia, stresses in trusses and the strength of the structures before a student has acquired a working knowledge of calculus, passed all requirements in physics, and has a working knowledge of descriptive geometry, shades, shadows and perspective, to say nothing of French or German, but "the proof of the pudding is in the eating," and the test of the educational system is an educated man, regardless of the thing he has studied or the progression of the subject matter.

One of the unexpected results of the introductory course was the beneficial effect on the English of the freshman year. The department attributes this to the fact that the students had something to write about, and showed a great desire to express it, not only in writing but from the platform, where they have been called to explain many things to their fellow-students and discuss the course itself.

So-called cultural studies are not necessarily cultural when prescribed at the beginning of the technical course. The desire for these studies should be a natural growth under the influence of instructors who have a sufficiently broad vision to realize that even technical education does not depend entirely upon subject matter, but is an assimilation of everything that goes to build character. If a student of engineering has not acquired some love for literature, art and the humanities through the influence of his course, I can but feel that there is something wrong with something or somebody somewhere.

If a student desires to specialize to a high degree during his senior year, I believe it is wise to open the gate wide to this field of education, and the new course provides amply for such an opportunity.

In conclusion, our aim in the new curriculum is:

1. To utilize the interest and enthusiasm with which a student enters the technical school, by introducing him at once to live engineering problems, and so to vitalize the task that the disciplinary value of study ceases to appear as such.

2. To make the freshman year of such value that if circumstances force the student to discontinue his course he shall have acquired a vision of greater things, and such training as will afford him some preparation for a place in the engineering world.

3. To determine as early as possible the fitness of the student for a special field of labor and, whenever it may be necessary, to make the transition to another field both simple and profitable.

4. To make the entire course so flexible as to adapt it to the continuous changes which takes place in the natural development of the student mind.

May we not hope to make the college course effective for that great class of students who have formerly been declared by our faculties as unfit material for the engineering profession, and yet who later happily disappoint us by becoming leaders in engineering practice?

Complete Reorganization Planned at Yale

By J. C. Tracy
Sheffield Scientific School, Yale University, New Haven, Conn.

THE following complete reorganization of the educational work at Yale University is planned for immediate adoption:

A. Reorganization of the University

1. The undergraduate course in the Sheffield Scientific School has been lengthened to four years.

2. The entrance requirements for Yale College (the academic department) and the Sheffield Scientific School have been made the same. This involved the dropping of Latin as an entrance requirement for Yale College and such higher branches of mathematics as trigonometry and advanced algebra as entrance requirements for the scientific school.

3. A common freshman year for all students, so that a boy will no longer enter Yale College or the Sheffield Scientific School, but Yale University. For this freshman year there will be a separate faculty and dean, members of the faculty to be selected for their ability as teachers of freshmen. This practically establishes a "junior college."

4. The elective system in Yale College to be modified so that there will be prescribed courses leading to various kinds of lifework, a system always followed in the scientific school.

5. A provost who will serve as chairman of the university council and devote his undivided attention to the educational work of the university, responsible only to the president and the Yale corporation.

6. A dean of students to assist the deans of the various schools in promoting morale, and to work with such student organizations as the student councils.

7. Courses in history and government, required of all students who have not had such courses at entrance to college.

B. Reorganization of Engineering Courses

1. Organization of a division of engineering in the graduate school.

2. Readjustment of such fundamental undergraduate courses as mathematics, chemistry, physics and English, in order to determine the scope and content of each course and to correlate these courses with each other and with the engineering courses which follow.

3. Addition of courses in economics, accounting and business finance for all undergraduate students in engineering.

4. Elimination of too highly specialized undergraduate courses in engineering and the broadening of aim in other undergraduate courses in engineering, so that construction and operation, as well as design, will be included to a greater extent than heretofore.

5. Elimination of required courses in foreign languages. (All students must still offer for entrance two years in each of two foreign languages.)

6. A common curriculum for all engineering students for the first two years, with short courses in engineering to promote interest in engineering and to show how the fundamentals of these first two years will be applied later.

7. A reduction in the required number of hours to a maximum of 45 per week, at the same time raising the standard of work.

8. Organization of a new department of engineering mechanics, with Prof. C. J. Tilden as head.

Modifications in Engineering at Kansas State Agricultural College

By A. A. Potter
Dean of the Engineering Department, Kansas State Agricultural College

IN ORDER to arouse and to maintain the interest of engineering students in their work, the Kansas State Agricultural College will require all freshmen engineering students to pursue certain intensive and concrete courses, closely related to the profession for which they are preparing. Each course will count for two semester units of credit and consist of six hours per week of combined classroom work, laboratory practice and supervised study, given by the older and more experienced teachers in the several departments. The details concerning these intensive courses follow:

1. All freshmen engineering students will take a two-unit course for one semester in plain surveying and a two-unit course for one semester in shop practice.

2. Freshmen mechanical engineering students will take a two-unit course for one semester in the elements of steam and gas power engineering. This will be a

nonmathematical course and will deal with the construction and operation of boilers, steam engines, steam turbines, steam power plant auxiliaries, internal-combustion engines, gas producers and power vehicles.

3. Civil engineering students will take surveying during their entire freshman year, six hours per week.

4. Electrical engineering students will take a two-unit course for one semester during their freshman year in electrical machinery and construction. This course will include electric wiring, and the operation and repair of electrical machinery.

The above outline has been tried out during the college year 1918-1919 and those responsible for the curricula feel that these intensive courses, offered during the freshman year, better prepare the engineering students for the more abstract subjects of the later years, while reducing the mortality by maintaining interest. The course, as given, includes about two hours per week of classroom work and four hours per week of laboratory work or supervised study. The teachers feel that a limited amount of supervised study enables the students to work problems independently, while aiding the teachers in making the instruction nearly individual.

In order to make room for the above courses, analytical geometry had to be shifted from the freshman to the first semester of the sophomore year and the course in calculus is given during the second semester of the sophomore year and the first semester of the junior year. One English course is shifted to the senior year.

Business Training for the Engineer

By Anson Marston
Dean, Division of Engineering, Iowa State College, Ames, Iowa

RETURNING last December to resume charge of our engineering college after an absence of a year and a half in the Army, the writer found local conditions opportune for radical improvements in engineering education. Conference with the engineering alumni of our institution showed that they are eager for such improvements but can make comparatively few clear-cut recommendations. On one point, however, they are definite and unanimous—they desire that our engineering students receive some broad training in simple, fundamental business principles, so that they shall not exhibit infantile helplessness in their early efforts to carry engineering enterprises to successful conclusion.

The new thought is: Why should not the engineer be his own employer in great industrial enterprises of an essentially engineering character? Why should he not be the organizer, the president, the manager of great industrial corporations rather than a mere hired expert?

Employers of Engineers Dissatisfied

Another cause for the present demand for business training for the engineer is the widespread dissatisfaction, among employers of engineers, with the product of our engineering schools. During the past fifty years our engineering courses of study and methods of instruction have become standardized to such an extent that it is almost as great a sacrilege for any engineering college to deviate from the general practice as it was for the ancient Egyptian draftsman to vary a line from the orthodox in representing Pharaoh.

The engineer employer needs, above all, men who are qualified for successful executive responsibilities in great industrial undertakings, and he is not satisfied with the product which our engineering colleges are sending out.

Even before the war, then, engineers and engineer employers were demanding business training for the engineer. Since the close of the war comes Uncle Sam himself to tell us that the imperative post-war needs of the United States require great engineer leaders with sound business training to develop our mechanic arts industries for economic and profitable production, transportation, sale and use, at home and abroad.

Wanted—Great Engineer Leaders

What we need is great engineer leaders like Captain Eads, Hugh L. Cooper, Thomas A. Edison, Alexander Graham Bell and John Hays Hammond, men who possess the highest engineering qualifications combined with great business ability, and who can conceive great mechanic arts enterprises, design their engineering details, build their greatest constructions, organize and direct their operations, and who also can interest capital and deliver a fair profit to investors.

I take it that the principal object of all business training (speaking baldly) is financial profit. Public utilities, for example, are successful from the business point of view whenever they make money for their stockholders, although they may poison a city with polluted water, furnish unsatisfactory light and power, cause the traveling public all sorts of inconvenience, or ruin industries by insufficient or inequitable transportation facilities. Toleration of such shortcomings, it is true, might be unwise, but this would be because they might arouse antagonism, cause enaction of legal restrictions, decrease patronage or otherwise operate to decrease profits.

In engineering, on the other hand, profit, though essential, is only one essential to be attained, and achievement in the successful utilization of the principles of the science of mechanics is the great object. The engineer has been trained to give primary attention to the scientific principles of design, to ingenuity in invention, to industrial organization for construction and production on the greatest scale and at the lowest cost. In planning business training for the engineer we should not attempt to lower the great ideals of his profession. We should add business training to the engineer's equipment, not substitute it for engineering qualifications. We should qualify the engineer to take into account, with due weights in the solutions of his problems, the great questions of capital, labor and profits as well as the scientific principles of engineering theory and experience. The engineer's remuneration should no longer be left to be considered as a mere item on the cost side of the books of the enterprise.

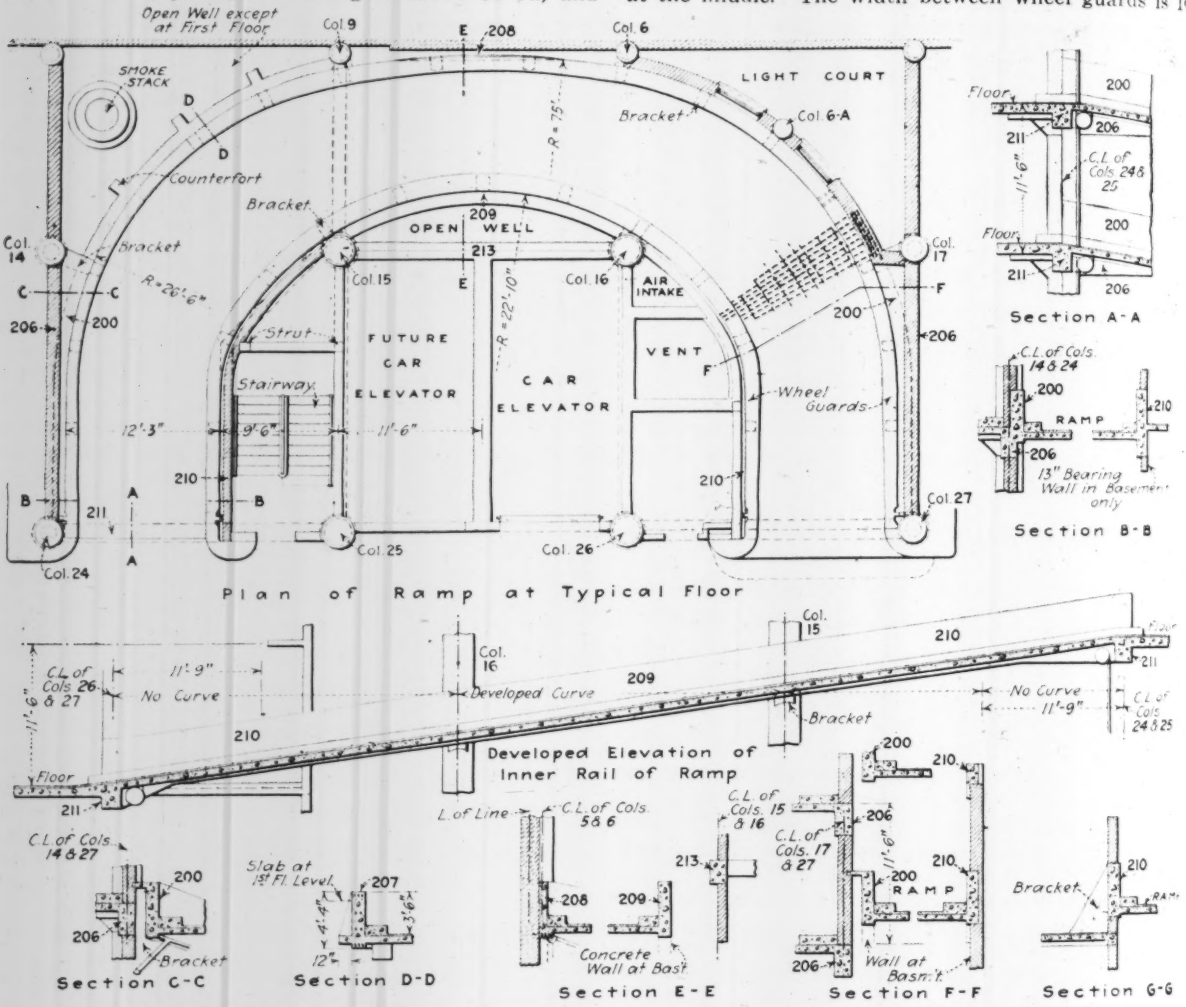
The only really adequate method for providing the business training now needed by engineers is to put it into the regular four-year courses (civil, mechanical, etc.) as required work to approximately the same extent as chemistry or physics. The writer earnestly believes that this should be done. Many curricula already contain certain work along business lines, such as economic science, business law as applied to contracts and specifications, shop management and industrial organization courses. Additional room ought to be provided sufficient for at least 10 semester credit hours of required work.

Curved Drive for Automobiles in Six-Story Garage

Incline Between Floors Gives Better Facilities Than Elevators and Is Made Part of Structural Framing

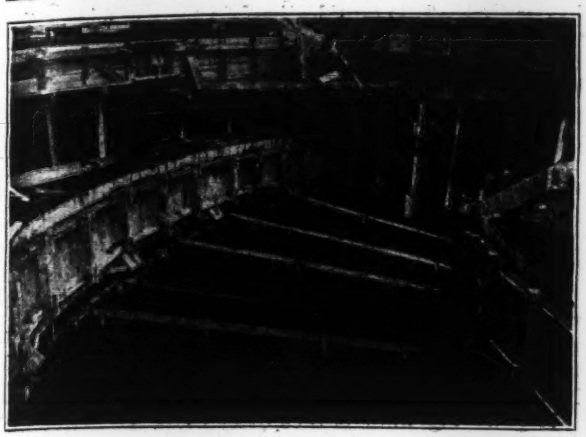
A CURVED concrete ramp or inclined driveway forming an integral part of the building is the means provided for handling automobiles between the floors of the six-story Washington garage and warehouse in Chicago. The building is 181 x 81 ft., and provides facilities for storing, washing, repairing and painting cars. It is of reinforced-concrete construction, with floors of the flat-slab type. At the middle of one side, and occupying half of the width of the building, is an area about 70 x 40 ft. which contains the ramp, the space inclosed within the curve being utilized for elevator shafts, ventilating shafts and a stairway. The elevators can carry cars for painting or repair work, but their combined capacity would be much too small for the general business of the garage. The cost of the incline is considerably less than that of a battery of elevators giving equal capacity, and no operating or maintenance costs are involved.

The driveway approximates a helical curve. Its layout is shown in the accompanying plan, together with the supporting girders, columns and brackets. Its average inclination or rise is 11°, with 13° at the inner curve and 9° at the outer curve. A turn of 180° suffices for each stretch, with a tangent about 12 ft. long leading off the lower floor and followed by a curve which ends in a second tangent opening onto the upper floor. The inner side of the turn has mainly a radius of 22 ft. 10 in. The outer side is a compound curve, with radius varying from 26 ft. 6 in. at the ends to 75 ft. at the middle. The width between wheel guards is 1[illegible] ft. 3 in. on the tangents, increased to about 11 ft. on the turns and reduced to 8 ft. at the middle of the curve.



CURVED INCLINE DRIVEWAY CONNECTING FLOORS OF CONCRETE GARAGE IN CHICAGO

Typical construction is shown by the accompanying view and drawing. Supporting girders are formed by the curved inclined curb walls, which are 12 in. thick and 51 in. deep, having their tops 41 in. above the base of the 5-in. concrete slab of the driveway. Broad wheel guards 9 in. high protect the parapets, and the outer parapet is braced by counterforts as a precaution against shocks from runaway cars. Two-way reinforcing is used in the slab, which is designed for a live load of 100 lb. per square foot. A good grip for



CONCRETING THE FLOOR AND GIRDERS ON CURVE OF INCLINED DRIVEWAY

the wheels i insured by leaving the surface of the concrete rough as poured.

While flat-slab floor construction is used, girders are introduced between the columns on the three interior sides of the area occupied by the ramp, in order to form a braced panel. Column spacing is so arranged as to admit and support the ramp and brackets on the main columns support the curved inclined girders. On one side a supplementary column (6 A) is placed to support the outer curved girder, upon which is built a wall inclosing the light shaft. On the opposite side of the turn this column is omitted, as clear space was needed for the mechanical equipment in the basement and there is no wall built upon the girder to inclose a light shaft.

Holabird & Roche were architects and engineers. The contractor was the G. A. Fuller Co.

Single-Leaf Bascule in Double-Leaf Bridge

REVERSAL of a single-leaf bascule span and its utilization as part of a double-leaf bascule bridge is the plan adopted for the new bridge to be built over the Chicago River at 12th St.. This arrangement is made to provide for the straightening of the river, by which the west or trunnion pier of the new bridge now to be built will become the east pier of the future permanent bridge. The construction of the single-leaf span as a temporary crossing of the present channel is necessitated by the demand of the United States Government for the removal of the old swing bridge at this point. Originally, it was proposed to use a bridge of the direct-lift or lever-lift type, as described in *Engineering News* of June 17, 1915, p. 1196. It was proposed to shift the structure bodily to the new position, in that case. The bids were far in excess of the estimates, however. The single-leaf skew bridge now agreed upon will be 175 ft. long, crossing a 140-ft. channel, while the future double-leaf bridge will span a 200-ft. channel. The plan as approved by the city and the Sanitary District of Chicago has been submitted to the War Department.

Report Form for Water-Treatment Plants

AS A part of the system of control of water-purification plants in Wisconsin made a duty of the State Board of Health under recent legislation, a monthly report summarizing operations and results is required. The form employed is shown herewith. The intention of the board is to conduct an efficiency run of each purification plant once a year. E. J. Tully is state sanitary engineer.

State Board of Health

Monthly Summary of Operations and Results

..... Water Purification System. Month of .....

Date	Gallons water pumped.	Pounds of Liquid Cl. per 24 hrs.	Pounds of "Hypo" per 24 hrs.	Parts per Mil. Av. Cl.	Free Cl in treated water	Bacteriological Examinations: Raw water 20°C count	Raw water 37°C count	Raw water B. coli group (5) 1 cc	Raw water B. coli group (5) 10 cc	Treated water 20°C count	Treated water 37°C count	Treated water B. coli group (5) 1 cc	Treated water B. coli group (5) 10 cc	Remarks
1														
2														
3														
4														
29														
30														
31														

Approved..... State Sanitary Engineer. ..... Supt. or Operator Water Dept.

Date	Number of filters on	Hours of Service of Filters Length of Run 1	2	3	4	5	6	7	8	Av. filter rate	Loss of head Initial and Final 1 I.	1 F.	2 I.	2 F.	3 I.	3 F.	4 I.	4 F.	5 I.	5 F.	6 I.	6 F.	7 I.	7 F.	8 I.	8 F.	Washes Number	Min. per wash	Thousand Gals. Used Total	Per Wash	Per Cent	Alum Pounds Mixed	Used	Grs. per Gal.	Color P. P. M. R	Filter Effluents 1	2	3	4	5	6	7	8	Alkalinities Raw	Clear Water	Remarks
1																																															
2																																															
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30																																															
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WISCONSIN FORM FOR REPORT ON WATER-PURIFICATION PLANTS
The form is printed on the two sides of an 8½ x 11-inch sheet

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Suggests Scheme of Organization for National Engineering Council

Sir—At the Conference of Technical Societies held in Chicago in April, 1919, it was plainly set forth by Gardner S. Williams that in organizing the engineering interests of the country there are two distinct phases—namely, the technical and the welfare—calling for two distinct bases for organization; furthermore, that the technical was being well cared for by the founder societies; that it was necessary for them to uphold the high standards of the profession, and that they must not lower their requirements for membership. On the other hand, the organization for the welfare of the profession must include all those who are drawing their income from the engineering profession and that, therefore, the requirements for membership must be much more liberal than in the founder societies.

Referring to the report of the Committee on Development of the American Society of Civil Engineers, we find in the appendix by Charles Warren Hunt the same ideas expressed, with a tentative plan of an organization to develop the welfare phase of engineering. It is here stated that the organization must be loose and must be democratic; that it should consist of a national organization founded on local organizations. The name "Engineering Council" is suggested for the national organization.

If the above conclusions are sound—and we are firmly convinced that they are—the organization of engineers for their common welfare is not receiving the publicity its importance demands. The technical educational and scientific phase of engineering has been well cared for by proper organizations for fifty years, but the profession is groping in darkness to find a suitable organization to represent the welfare of its members, and to assist in giving to the public the best service of which the profession is capable.

The writer wishes to suggest the following scheme of organization, hoping that by discussion definite plans may speedily materialize. This plan would comprise three classes of organizations, as follows: (1) A national organization known as the National Engineering Council, composed of one or more delegates from each state, depending on the number of engineers in the state; (2) a state organization in each state known as the (name of state) Engineering Council, and composed of one or more members from each local engineering organization in the state; (3) local organizations, such as present state engineering organizations, county organizations, city clubs, etc.

To provide uniform and equitable methods of representation in the higher councils, the requirement might be made that each member of the National Engineering Council must be a member of one of the founder societies, and that the basis for determining the number of members from each state should be the number of members of the founder societies residing in the state in question. This would stimulate membership in the technical societies and also furnish an exact and convenient method of apportioning the membership of the national council among the states. All the members of the founder societies residing in a state would then meet and organize the state council. This state council would then consider all organizations in the state having to do with engineering, and after examining their constitutions and requirements for membership decide which ones of these organizations should be represented in the state council.

In financing the entire scheme the local organization would decide on the local dues; to this would be added the state dues fixed by the state council, and, finally, to this sum would be added the national dues fixed by the national council.

Engineering work is occupying the attention of the entire nation in an unprecedented manner and the engineers owe it, not only to themselves, but to the public at large, not to delay an organization that can deal with the business interests of the country.

Topeka, Kan. LLOYD B. SMITH.
Secretary, Kansas Engineering Society.

Wheel Loads on Highway Bridge Floors

Sir—Many highway bridges in the Pacific Northwest are designed with wood floors resting on longitudinal steel or wood stringers, spaced from 2 to 3½ ft. between centers. The floor plank is usually 4 in. thick, laid transversely, and spiked to wood strips, which are bolted either to the top flanges or to the webs of the stringers. The planks are generally 12 in. wide; in some cases 3-in. planking is specified, and in others the thickness is made greater than 4 in. Laminated floors, composed of 2-in., or, more frequently, 3-in. pieces, stood on edge and spiked together, are also used.

When steel stringers are used, they form quite an item in the weight of steel in the superstructure and it becomes a matter of importance to determine what proportion of the wheel loads is supported by any one stringer; also whether the concentrated load may be considered as applied to the stringer at a point or whether it has the effect of a load uniformly distributed over a portion of the length of the stringers.

Investigations have been made by A. T. Goldbeck, W. T. Slater and the Ohio State Highway Commission on the distribution of concentrated loads in reinforced-concrete slabs and the steel or reinforced-concrete beams which support them. We have therefore, within certain limits, reliable information on which to base the design of bridge floors of these types. But we are largely at sea in the proportioning of floors and stringers for bridges having plank floors on wood or steel stringers. There seems to be little information and not much uniformity of opinion on the subject. B. S. Myers reported in the *Iowa Engineer* of the Iowa State College on some experiments made with six-ton and eight-ton steam tractors on a bridge with wood floor and steel beams to show the distribution of the loads. The tractors had wide wheels, and the writer believes that the results would not be correct for motor trucks, which have wheels with much narrower rims in proportion to the loads. A few specifications and several technical books touch the subject lightly, but they are not very satisfactory.

The following questions enter into a consideration of the problem: With planks 6 to 12 in. wide, laid flat, is the wheel load supported entirely by one plank, or by more than one plank? With a laminated floor, what is the width of floor in a longitudinal direction which may be assumed to support the wheel? Can the floor plank be considered as a continuous beam of several spans? Will the spiking or other fastenings at stringers be sufficient to fix it at these points? What effect on the continuity does the deflection of the various stringers produce? Are the outer ends of the planks simply supported, partially fixed, or fixed? What allowance should be made for poor workmanship, insufficient maintenance, and decay?

The writer has settled temporarily on the following: Figure the plank as 1 in. thinner than the thickness specified, to allow for wear and decay. With plank laid flat consider that the wheel load is carried by a single plank. With a laminated floor, consider that the wheel load is supported by a strip of floor having a width equal to four times the thickness of the floor. Figure the wheel load as uniformly distributed over a length of plank equal to the width of tire or rim in contact. Make no allowance for the value of spiking at stringers. Consider the plank as a cantilever on each side of the stringer over or near which a wheel load is placed. Using the fiber stress already given, find the resisting moment of the plank, and add to it the moment produced by the weight of the free end of the plank. Divide this by the distance to the next stringer, and use the quotient for the reaction on this stringer. Subtracting twice this value from the total wheel load will give the maximum load on an intermediate stringer.

For outside stringers place the wheel as near the curb or guard rail as practicable, and figure the plank as simply supported at the outer end, and fixed under the inside wheel. Make outside stringers as strong as intermediate stringers, and do not design any stringer for less than 50% of the wheel load. Consider the load as applied to the stringer at a point, and placed in the position which gives the maximum bending moment.

Use the lightest weight of each size of I-beams, and space stringers so that they are used to the full safe value. Preference is for the deeper I-beams and wider spacing; but the maximum limit for spacing is about 3½ ft. When stringers are riveted to the webs of floor-beams with substantial connection angles they are partially fixed at the ends, and the bending moment obtained by treating the beam as simply supported may be reduced 10%.

When the minimum depth of stringers is taken at about $\frac{1}{15}$ of the span to avoid excessive deflection, the thickness of the floor plank will usually determine the spacing of the stringers. The heavier wheel is placed at or near the center of a length of plank between two stringers, and the plank is assumed to be freely supported outside of the truck or roller, and fixed under the opposite wheel on the axle.

The width of tires in contact with the floor is not more than 10 or 12 in. for many heavy motor trucks. In my opinion, the sizes of beams and channels for beam bridges, American Bridge Co.'s standards, given in Professor Ketchum's "Structural Engineer's Handbook" are too light. A discussion on this feature of bridge design would be valuable.

HENRY F. BLOOD.
Portland, Ore. Structural Designer.

Defends Aggregate Grading Theories

Sir—I have read with interest the article "Tests of Two Recent Theories of Proportioning Concrete" in *Engineering News-Record*, June 12, 1919. It is important to note that apart from the question of "workability" the authors, after having proved to their own satisfaction the inadequacy of the methods in question, have refrained from a discussion pointing out the probable reasons for the failure of these methods and suggesting possible means for rectifying their deficiencies. In general, the spirit of the article appears to be destructive rather than constructive. The criticisms and the test records it contains are, I venture to think, especially unfair to both the "fineness-modulus" and the "surface-area" methods of proportioning.

Practical considerations do not appear to have entered into the planning of any portion of the entire series of tests. A casual consideration of Table I indicates that more than one-half of the aggregate gradings do not conform to the basic requirements for mortar and concrete aggregates recognized by standard specifications. Furthermore, the test specimens were neither uniform in size nor in shape, and apart from this the number of specimens for any given test was insufficient for the securing of proper, well balanced averages. The inadaptability of these conditions to the investigation of any method or theory for the design of mortar and concrete mixes renders it useless to attempt to analyze the results obtained.

The writer's paper, "Proportioning the Materials of Mortars and Concretes by Surface Areas of Aggregates" (See "Proceedings," American Society for Testing Materials, Vol. XVIII, and *Engineering News-Record*, Aug. 15, 1918, p. 317, gives a very complete description of the development of the "surface-area" method and contains the description and the results of all tests made with this method up to June 1, 1918. The data there shown indicate very clearly that the investigations were entirely confined to the use of aggregates having normal, natural gradings. Even the two sands mentioned as having "rather irregular or freak gradings" would fulfill the requirements of well known sand specifications in general use. It is, therefore, reasonable to assume that the development of this method involved no radical departure from recognized good practice in so far as aggregates are concerned. However, it is to be regretted that a paragraph discussing fully, its inadaptability to "freak" aggregates was deleted from the original manuscript of the paper above mentioned. It was believed that practical utility would dictate the proper limits of its application.

Before proceeding further it is proper to call attention to an evident misunderstanding on the part of the authors, in relation to the very limited concrete investigations described in the A. S. T. M. paper. In the three tests made the water content of the mix was not proportioned by rule, but instead, as the paper states, "the water content of the mix was sufficient to produce a saturated, sticky, semiplastic mortar showing no free water." It further states, that "at the time of making the test specimens (concrete) the approximate areas of broken stone and gravel aggregates had not been determined," and in consequence of this condition the area of the stone aggregate was not taken into account in proportioning the cement in the mixes. However, notwithstanding these shortcomings, the con-

sistent test results obtained were belived to indicate amply the adaptability of the method to concrete mixes, and they were accordingly described in the paper.

The formula quoted by the authors is specifically dealt with under the heading "Mortar Consistency Tests." No reference whatever is made indicating or tending to indicate its adaptability to concrete mixes. Furthermore, the paper contains no formula adaptable to the proportioning of the water content of concrete test specimens.

While the physical conditions involved in commonly used concrete mixes containing one part mortar to two parts stone aggregate preclude the use of the consistency formula adapted to the production of "normal" mortars containing well graded sand aggregate, it is perhaps, unfortunate that this fact was not clearly pointed out. However, it is to be specially noted that while the first paragraph of the article in question indicates very clearly a misconception of the application of the consistency formula above mentioned, yet we find in the third and fourth paragraphs its proper application described with equal clearness.

The "surface-area" method bears no direct mathematical relation to other methods which have been proposed from time to time. It is, therefore, not comparable with the methods used in the tests described in Tables II, III, IV and VI of the article in question. References to it in these tables are, therefore, not only misleading but also entirely out of place. They serve no useful purpose, since they cannot possibly prove or disprove anything. Their use in this conection is unfortunate.

Another feature of this article which appears to be characteristically misleading is the italicized statement that the "surface-area" method leads to the same conclusion as does the "water-cement ratio." The algebraic demonstration following the statement just mentioned proves absolutely nothing. Had the authors assumed with a given sand, say, four mortar mixes in which the cement varied in the relation of one gram to 10, 15, 20 and 25 sq.in. and compared the computed quantities of water and cement they would, doubtless, have discovered that, strictly speaking, the water-cement ratio varies with the richness of the mix and is a dependent function rather than a primary one.

With reference to the assumption made by the writer in his original tests whereby the dust content of the sand aggregate (material passing a No. 100 sieve) was treated as having the same surface area as an equal portion of material passing a No. 80 and retained upon a No. 100 sieve and the cement content proportioned accordingly. Subsequent tests have shown that this assumption was entirely wrong in principle, and that instead we must treat it as a "dilutant" or an "extender" of the cement rather than as a component part of the sand aggregate. Briefly, these tests have shown that in so far as the cement content is concerned no surface-area allowance should be made for sandy dust material and that the water allowance for moistening it is nearly equal per unit of weight to that required for cement.

Space does not permit an attempt to enumerate all the factors influencing the physical properties of mortars and concretes. The work of defining the rolês of each is making slow but certain progress. However, in our efforts to ascribe to each its function, we must constantly bear in mind that these factors are to a marked degree interdependent. We must also keep in view the fact that, broadly speaking, a finished mortar or concrete is composed of (1) materials and (2) making, either of which may at times become the superior, regulating force upon which the quality of the resulting material mainly depends. This combination is awkward. However, it seems entirely rational to assume that, since cement and water are unquestionably the primary materials functioning to produce strength, they form the natural basis upon which to develop methods for the design of mortars and concretes. The "fineness-modulus" and the "surface-area" methods, although differing in other respects, recognize the importance of this basic condition.

The above mentioned interdependence of various factors is indirectly referred to by the authors in their discussion of the mobility of the mix or, to use their words, its consistency, workability, plasticity or flowability. However, they have apparently failed to recognize this interrelation in full and have given it a primary instead of secondary importance by disregarding the fact that a dilution of the cement matrix in the "making" stage results in a final decrease in its strength.

LLEWELLYN N. EDWARDS,
Senior Highway Bridge Engineer,
Washington, D. C. Bureau of Public Roads.

Escaping Water Important in Concrete Tests

Sir—I have read with considerable interest articles published in *Engineering News-Record* with reference to Prof. Duff A. Abrams' water-cement ratio tests, and recent criticisms by Bureau of Standards engineers of the fineness-modulus and surface aggregate methods.

So far as I have been able to see from reading these articles, one very important factor which enters into the final uniformity and ultimate strength of concrete in compression has either been entirely overlooked or has not received publication by these writers.

First of all, it would be very interesting to know the type of molds used in these various tests. Are they practically waterproof? Does the water which is used in mixing remain in the concrete, or does a portion escape through and underneath the molds—and if so, about what percentage does escape? Are the molds filled to overflowing and tamped, rodded or tapped on the sides, and is the excess water which gathers at the top allowed to escape as more concrete is added to fill the mold for a finish? Either of the above methods of handling the concrete after it is placed in the molds has a great bearing on the ultimate strength when tested. In my opinion, based on laboratory tests, it is not so much a question of the amount of mixing water *used*, but rather of the amount of water in the concrete after the final set has taken place—or, in other words, how much of the water is allowed to escape either forcibly by rodding or naturally by evaporation and leaks through the bottom and sides of molds if they are not water-tight, or over the top of the mold when concrete is added to make a full mold?

It has been found through tests made by the writer that the strength of concrete can be increased from 25% to more than 100%, depending upon the amount of rodding and upon the strength of the unrodded concrete—the percentage of increase being highest with the weaker concrete mixes. Most of these tests were

made in 6 x 12-in. No. 18 galvanized-iron molds clamped together on the sides and placed loose on a machined iron baseplate, so that much water escaped through the sides and under the molds. The type of molds in this case was, no doubt, responsible to a great extent for the high increase in strength, which would also be true of other laboratories using molds which would allow water to escape. We have also obtained large increases in strength by this method in water-tight molds.

The writer does not wish to leave the impression that he is advocating the use of more water than is necessary for the proper workability, nor making any adverse criticism to the work of any laboratory, but merely wishes to see if something cannot be done toward making clearer the exact methods, in use in different laboratories, of mixing, placing and handling concrete, the type of molds used, etc. Our tests show that there is a wide variation due to different methods, and until laboratories understand the exact methods of other laboratories and use similar methods of handling, etc., where possible, there will never be the coöperation and progress there should be. G. A. PARKINSON,

Assistant Testing Engineer, University of Texas.
Austin, Texas.

[Professor Parkinson's letter was submitted to the two laboratories concerned and has elicited the following replies.—EDITOR].

Sir—In all of our tests metal molds have been used, with the exception of a few instances in which we made a study to the effect of using cardboard forms. The method of molding the specimens in our laborat ry is described on p. 5 of our bulletin 2 and also on p. 3 of my paper on the effect of vibration and pressure, etc., presented at the recent convention of the American Concrete Institute.

In our laboratory the machined metal form stands on a machined cast-iron baseplate, except that a sheet of paraffined tissue paper is placed between the form and the baseplate. This makes practically a tight joint, so that there is no leakage of water. For the wetter consistencies where leakage might be encountered, we seal the outside of the bottom joint and the vertical slot in the mold by means of paraffin.

In making a study of the effect of consistency of concrete where the water content may be varied, we do not consider it proper to permit the escape of water, since this would, of course, produce a material difference in the strength of the concrete.

Our specimens are molded by placing the concrete in the forms in layers of about 4 in. in 6 x 12-in. cylinders, puddling by means of a ⅝-in. round bar, pointed at the lower end, with about 25 strokes of each layer. This process of filling and puddling is continued until the mold is full. The last layer generally fills the mold to overflowing. The excess concrete is removed by means of a bricklayer's trowel, and the top of the specimen leveled off. In the very wet mixtures where the excess of water tends to collect at the top, we allow the water to stand for a time, then fill the mold with additional concrete. The fact that the water does stand for a period of 20 min. to one hour before removing seems to produce the same effect on the concrete as if it were allowed to remain indefinitely. D. A. ABRAMS,

Professor in Charge, Structural Materials Research Laboratory.
Chicago, Ill.

Sir—All test specimens made at the Bureau of Standards are molded in iron or brass molds resting on glass plates. They are waterproof and practically water-tight.

In molding, a slight amount of water—or, rather, cement grout—is apparent around the lower end of the mold. This quantity is only a small fraction of 1% of the quantity of water used. The molds are filled full and rodded and possibly a small amount of water escapes before the neat cement paste capping is applied.

I fear that there is really nothing to this argument that a possible loss of water in molding may tend to account for the variation in strengths, since it is evident that the tendency of this water to escape would be greatest in the wettest mixtures and since the latter are those which have the lowest strength, the loss of water from these mixtures would tend to equalize the strengths. J. C. PEARSON.

Acting Chief, Cement Section, Bureau of Standards
Washington, D. C.

Practice in Gagging Rails

Sir—The editorial remarks on "Cracks in Rail Steel," published in *Engineering News-Record* of July 3, 1919, p. 2, contain a statement, near the end of the second paragraph, that should not pass without contradiction. The statement that "gagging affects only the middle part of the rail's length" implies that there is no gagging near the ends of rails. As a matter of fact, there is a great deal, and it may be of the most injurious character. The uniform sweep that rails contain coming off the hot beds requires "working" the rails in the straightening presses to almost the extreme ends. In addition, short bends and frequently kinks occur near the ends, and sometimes so near that a "dutchman" has to be used to support one end of the rail in the straightening press. The blows given near the ends of a rail are apt to be of the most injurious character, as, obviously, almost the full weight of the rail is acting as a lever against the gag and the whipping action is more severe.

Attention has been repeatedly called to the fact that a large amount of gagging can be entirely dispensed with by permitting rails containing a small amount of sweep, say 1 in. in 33 ft., to be shipped unstraightened. Experience shows that such rails can be easily spiked to perfect line and surface. This leniency, if granted in the specifications, would eliminate a vast amount of expensive mill work, leaving opportunity for generous improvement in other directions and, in addition, greatly reduce the suspicion invariably attached to the gagging of high-carbon rails. C. W. GENNET, JR.,

Chicago, Ill. R. W. Hunt & Co., Engineers.

Engineers Have Long Been Underpaid

Sir—Some of the recent discussions regarding compensation for engineers would lead to the belief that it is only recently that the profession has been inadequately paid. As far back as my engineering experience reaches, namely, eighteen years, this feature of low pay for the class of service rendered has been prominent, and it is unnecessary to compare the purchasing power of the dollar today with that of fifteen years ago to reach this conclusion. When a prominent steel works considered at that time that $7 per week was good average starting pay for a graduate engineer in its

drafting room, $9 extra good, but paid $12 in some cases for detailers, the evidence is plain. For $150 per month a large municipality could secure the services of an able engineer for executive charge of a million dollar improvement project. Similar instances can be cited by any engineer who is conversant with those times.

Although salaries have increased somewhat in the past fifteen years, they have nevertheless remained far below their proper basis, and when the recent abnormal conditions brought about a great advance in labor's rate of pay, the engineer's was not visibly affected. Moreover, public improvements were shelved for the time being. What shall we say of a concern employing many thousands of men, which today rewards the head of its large drafting force, who is in responsible charge of specialized work, with a salary of less than $200 per month? And this, too, after seventeen years of faithful service. Truly, engineering service is to be had cheaply, and this has been true for at least two decades; perhaps longer.

It has been said in these columns that the vast majority of engineers will always be employees, whereas the devotees of medicine and law are in large measure free from this feature. True, and the engineer is moreover absolutely dependent upon the activity of capital for a livelihood. If capital is timid, the engineer's services are not required, except for purposes of upkeep and maintenance, regardless of his experience and skill. The physician or legal expert who specializes in some branch of his profession is quite likely to find that a demand for his type of skill will exist many years hence. The engineer, on the other hand, before specializing should be able to look ahead at least forty years, and determine whether or not there may be periods of depression, or wars, which would render his specialized knowledge a drug on the market, or even obsolete. Is it really, then, remarkable that some classes in the profession are contemplating or even taking radical steps to improve their conditions?

When engineers themselves are found more frequently among the promoters of projects, in place of the familiar figure of the booster, we may hope for some betterment. But at present most of us wait for someone else to take all of the initial steps and then offer us a job. Under these conditions we can be but high-grade hired men, subject to the whims of chance.

Philadelphia, Penn. P. M. FOGG.

Nomographic Chart for Solution of Manning Formula

Sir—Professor Sayre's chart, published in your issue of June 5, 1919, p. 1126, is decidedly a step forward in the practical methods for the solution of Manning's formula for the flow of water in pipes or open channels. The accompanying nomographic chart, however, is in my opinion still simpler and more convenient for practical purposes, covering the same wide ranges of the four variables.

The construction of this chart is quite simple, and is based on the following:

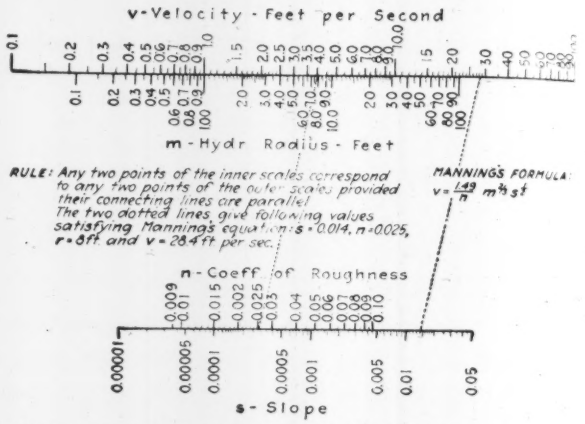
Manning's formula can be written thus: $\frac{v}{m^{\frac{2}{3}}} = \frac{1.49 s^{\frac{1}{2}}}{n}$

hence $\log v - \frac{2}{3} \log m = (\log 1.49 + \frac{1}{2} \log s) - \log n$

Lay off the values of $\log v$ to any convenient scale, say 3 in. = log 10, on one side of a straight line, and the values of $\frac{2}{3} \log m$ on the other side of the same line and from the same starting point (log 1.0).

It is evident that any segment between any two points of that line will equal $\log v - \frac{2}{3} \log m$, v and m being taken on opposite ends of the segment.

On another straight line, drawn parallel to the previous one and at any convenient distance from it, lay off to the same scale the values of n and on the opposite side the values of $\log 1.49 + \frac{1}{2} s$ to the same scale and


v - Velocity - Feet per Second
m - Hydr Radius - Feet
RULE: Any two points of the inner scales correspond to any two points of the outer scales provided their connecting lines are parallel. The two dotted lines give following values satisfying Manning's equation: s = 0.014, n = 0.025, r = 5 ft and v = 28.4 ft per sec.
MANNINGS FORMULA
n - Coeff of Roughness
s - Slope

NOMOGRAPHIC CHART FOR SOLVING MANNING FORMULA FOR FLOW OF WATER IN PIPES

from the same origin. Any segment between any two points of this line will similarly equal (log 1.49 + ½ log s) — log n to the chosen common scale.

If now the two scale lines are intersected by two parallel lines, these will intercept two segments of equal length, so satisfying the equation $\log v - \frac{2}{3} \log m = \log 1.49 + \frac{1}{2} \log s - \log n$.

Hence, given three variables, the fourth one can be determined by drawing two parallel lines as shown on the chart. M. J. SHAMRAY.

New York City.

Proposes a National Bureau of Art

Joseph Pennell, well-known as an artist who has adopted engineering structures as a field for artistic expression, in an address before the Engineers' Club of Philadelphia, published in the *Journal* of the club for July, mentioned the great artist-engineers of the past, Michael Angelo and Leonardo da Vinci, and advocated a Federal Department of Art. He said in part: "This country should have, as every civilized country in the world has, except Great Britain—and she would have had it if she had not had the war instead—a minister to control, direct, and advise about art, and engineering is a part of it. If you adopt that idea of a minister of art, under him will be included the artists, the architects, the musicians, the players, and even the circus tent, because, to go back again for a moment, when the Greek engineers designed their structurally perfect buildings they always had architects, sculptors, and painters to decorate them. And that is what we have to do again today. You engineers must work with us, and we are bound to work with you."

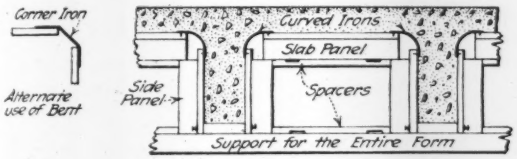
HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Floor Forms Designed for Easy Stripping

BY PROVIDING special curved corner strips of tin, Samuel P. Baird, engineer and contractor, of Columbus, Ohio, has greatly facilitated the stripping of concrete floor forms in his work. The design of the typical form is shown on the accompanying drawing.

In erecting the form, the trestle labeled "Support for the Entire Form" is first put up. Then the beam pieces



EASILY DETACHABLE CONCRETE FLOOR FORM

are placed in exact position and the side panels are nailed, with double-headed nails, to the bottom beam pieces. The lower spacer is then nailed only to the side forms, and the top panel, with the spacer attached, is placed. The curved galvanized-iron pieces are next attached, as shown, by tacks. These pieces are made up in a tin shop and well soldered. They are 16 in. long each way and lapped over the adjoining pieces so that no cutting is required.

When the forms are to be stripped, sufficient additional supports are placed under the beam bottoms, the upper and lower spacers are removed and the trestle support is lowered about 1 ft. by means of four pulley blocks supported by previously placed wire loops in the slab ceiling. These loops come through No. 20-gage circular plates 12 in. in diameter which cover holes in the ceiling panel, permitting the panels to fall when the double-headed nails are drawn. Notches are cut in the spacers so that a bar can be inserted to pry them out.

When the double-headed nails are drawn the entire form is free, except for the adhesion to the concrete. If the forms have been well oiled this will be small, and by shaking the forms they will generally fall the short distance to the support. When all the panels in the bay are down on the support, the entire form is lowered by the pulley blocks.

Instead of curved corner pieces, the angular piece shown in the alternative sketch is sometimes used. This is cheaper but has not as good an appearance as the curved corner. All of the corner pieces may be used many times, the only damage being due to too secure tacking.

Road Digger for Breaking Old Macadam Preparatory to Resurfacing

BREAKING up old macadam surfaces, preparatory to reshaping with a road machine and resurfacing, was accomplished in Niagara County, New York, with the device shown in the accompanying illustration. The old macadam had become very rough and full of pit

Other Articles in This Issue of Interest to Contractors

Chartered Summary of State Concrete-Road Specifications — Page 160

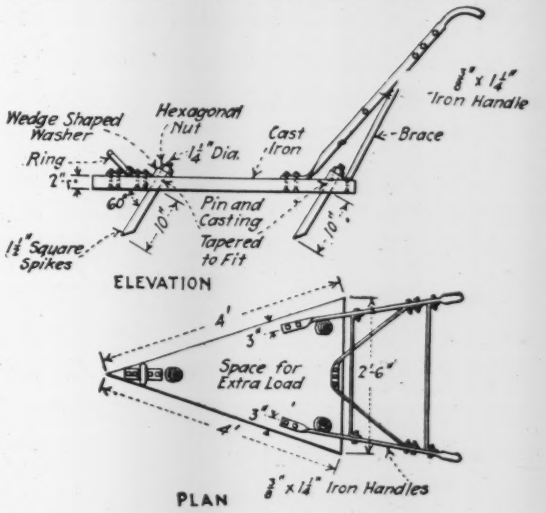
Backfilling Tunnel Through Holes Bored From Surface — Page 174

Large Concrete-Cased Steel Pipe Laid in One Piece — Page 176

Democracy or Partnership in Labor Management — Page 177

holes and humps, due to frost action. Essentially, the tool is the same as a garden cultivator, except that it is built heavier and does not have as many teeth.

It consists of a V-shaped cast-iron plate 2 in. thick, with handles and three spikes projecting downward and forward. The flat top furnishes surface for piling



PLAN AND SIDE ELEVATION OF MACADAM DIGGER

extra weight. Alone it weighs 300 lb., and on the Niagara work it was loaded to double this amount. A kerosene tractor was used to haul it.

The above facts were taken from the *Concrete Highway Magazine* for July.

Dishpans Used for Light Reflectors

BY ALBERT S. FRY

Morgan Engineering Co., Memphis, Tenn.

ORDINARY tin dishpans are successfully used as reflectors for the electric lights which are placed on the booms of the walking dragline excavators, working in the Inter-River Drainage District of Missouri. The bright tin surface of the inside of the dishpan makes a good reflector, at a small cost. The lights themselves are run from a plant on the excavator.

NEWS OF THE WEEK

New York, July 24, 1919

Illinois Central Plans New Lakeside Terminal at Chicago

Electrification and a new terminal station for the Illinois Ceneral R.R., and a 1200-acre lake-front park development, with provision for harbor facilities, are the main features of a new ordinance passed by the Chicago City Council, July 21. This represents an important step following several years' debate and controversy between the city, the railway, the South Park Commission and the Federal Government. By the terms of the new ordinance the Illinois Ceneral R.R. will introduce electric traction on its suburban lines within seven years and on its main lines in from 12 to 15 years. There is to be an elaborate new station on 12th St., the site of the present station, which will be a terminal for main-line trains but a through station for suburban lines which will pass under and continue to a local terminal at Randolph St. Freight traffic will pass outside the station to yards on the Chicago River. The matter will now go to the War Department for approval.

The New York Port Commission Makes Preliminary Report

Study of the problems of developing the port of New York is being continued by the New York-New Jersey Port and Harbor Development Commission, according to the progress report of that body, just issued. As yet the commission is not ready to make a definite statement on any of the details which go to make up the port work, but hope to be able by next year to complete its work and make detailed recommendations. The report outlines, however, the studies which have been made into the present operation of commerce in the port. It is the opinion of the commission that coördinated action between the various Governmental bodies contributing to the port must be assured if the development of the harbor is to continue at its proper rate.

Engineer Training School at Camp A. A. Humphreys

Maj. Gen. William M. Black, chief of engineers, recently appeared before the military committee of the House of Representatives to ask for authority to complete temporary construction at Camp A. A. Humphreys, which is located on the Potomac River a short distance below Washington. This camp was started about a year ago as an engineer training camp for both officers and men, and was not put into actual service until just before the ending of the war. Since then it has been used as an engineer school.

Employment Bureaus

Engineering Societies' Employment Bureau of the four founder societies, conducted by Engineering Council Employment service, for members and for other professional men introduced by members. Especial attention for those released from Government service. Address, 29 W. 39th St., New York City.

American Association of Engineers, 29 S. La Salle St., Chicago. Service to members only, but Army or Navy Engineers in uniform who are eligible to certified membership may join without payment of entrance fees or dues while in uniform and for six months after discharge.

Engineers' Service Bureau, 57 Post St., San Francisco. Only applications by mail or wire will be considered.

Professional and Special Section, United States Employment Service, 469 Fifth Ave., New York City.

Reëmployment Committee of New York City for Soldiers, Sailors and Marines, 233 Broadway, New York City.

It has been often reported that the Army would like to use Camp A. A. Humphreys as a permanent training school for engineers in the service, but General Black at this time is not asking for appropriations for this purpose. All he requires at present is about $400,000 to complete the temporary construction. He stated that it would cost about $3,000,000 to make the camp a permanent school.

Ask More Money for Alaska Railway

Bids have been introduced in both House and Senate authorizing the appropriation of an additional sum of $17,000,000 "to complete on or before Dec. 31, 1922, the construction and equipment of the railroad between Seward and Fairbanks, together with necessary sidings, spurs, and lateral branches." This amount is in addition to the $35,000,000 originally appropriated for the Government railway in Alaska, which sum has been nearly expended, though much of the work remains to be done. The excess of cost over estimate is largely due to the increased cost of construction. Hearings on the bills are to be held soon.

It is announced that the railway is available for freight or passengers from Seward north to Talkeetna, a distance of 227 miles.

Sues Cement Companies for Restraint of Trade

State of Kansas Asserts That Illegal Agreements Keep up Price of Portland Cement

Ouster suits against seven cement companies of Kansas have been filed in the State Supreme Court by the attorney general of the state. According to announcements, the suits follow extensive investigations made by the attorney general's office, based on charges that the cement companies have formed a trust, in violation of state laws, to fix cement prices. The petition prays that charters, franchises and business rights of the seven companies be forfeited, that restraining orders against continuing their combination be issued, that the property of all the companies be placed under the control of the court, that receivers be appointed, and finally that each company be fined not less than $100 for each day it has violated the anti-trust law.

The petition charges that the cement companies bound themselves not to sell, manufacture, dispose of or transport cement below a common standard figure which is termed excessive; that the companies have entered into a secret agreement to sell cement in Kansas at a uniform price, and add to said price and charge to the purchaser an amount equal to the railroad freight charges, not from the point of production to the point of delivery, but from the City of Iola, Kan., to the place of delivery, and that the companies agreed unlawfully to divide the territory of Kansas among themselves, to the end that in certain portions of the state certain companies have the exclusive right to fix the price of cement.

May Build 14-Mile Irrigation Tunnel in Washington

A tunnel some 14 miles in length, connecting the Methow and Okanogan drainage areas, is the main feature of the Methow-Okanogan irrigation project in Washington. The entire project embraces about 40,000 acres, from Chelan on the Columbia River to Riverside on the Okanogan. Of this area about 8000 acres are now irrigated under the Okanogan project of the United States Reclamation Service, and from other private sources of supply some 4000 acres are being watered. Unprecedented water shortage in this section led the districts concerned to ask the State Reclamation Service to make an investigation of the possible supply from the Methow drainage area. It was found by Elbert M. Chandler,

director and chief engineer of the Washington State Reclamation Service, that sufficient water could be obtained from the Methow River. Steps are now being taken to form a consolidated irrigation district, as provided for under recent amendments to the Washington irrigation district law. In addition, the lands are being classified, a soil survey is being completed and party is in the field making a preliminary survey of the proposed tunnel and canal line. If the project is found to be feasible and the necessary bonds are voted by the proposed consolidated irrigation district, it is thought likely, Mr. Chandler writes, that the State Reclamation Service will undertake the construction of the project and the purchase of the bonds, either jointly with the Federal Government or on its own account.

County Engineers Replace County Surveyors in California

Another state, California, has provided for county engineers to take over the work formerly done by county surveyors. By the passage of the Ream county engineer act, boards of supervisors are permitted to appoint county engineers to take complete charge of the management of county roads, and are compelled to make such appointment upon petition of 25% of the electors. While the boards of supervisors will hold general supervision over road matters, the engineer will be in complete charge of the design and construction of the roads, and will be constituted commissioner of each of the road districts in the county. In addition to performing the road work, he will take over all duties now performed by a county surveyor. As county road work has increased in importance, it has been found necessary in many places to replace the elected county surveyor, who often is not even an engineer and knows little, if anything, about modern road construction. In some cases this condition has been corrected by separating the offices of county surveyor and county road engineer. California has gone the whole way and given the county engineer the entire county engineering work.

Nevada May Have State Cement Mill

The Nevada state legislature has passed, and the Governor has approved, an act authorizing the Governor to appoint a commission of three to investigate the feasibility of the construction of a cement plant for the state. Section 3 of this act authorizes the State Board of Examiners to prepare and issue bonds in the sum of $100,000, the proceeds from the sale of which bonds are to be appropriated for the purpose of constructing and equipping such cement plant. This commission is to make a report of its findings to the 30th session of the state legislature, which will meet in 1921. There has been no report of the work of this commission.

War Factories To Be Sold

Manufacturing plants built for the war are about to be disposed of by the War Department. These consist of completed and partly finished manufacturing plants which were operated for, or under construction for, the use of all the different bureaus of the War Department. They include electrical, chemical, ammunition, gun, power and other plants, and are located in every part of the country.

It is provided in the contracts under which these plants were erected that they become the property of the United States Government at the end of the war, and in many instances it is stipulated that they be removed within a certain stated period after operation ceased. The Government, however, holds options on all the land, and it is possible to turn the entire plant over to a purchaser.

It is the policy of C. W. Hare, the director of sales, under whose direction these properties will be sold, to offer them first to the industries which have operated them for the Government during the war. If no sale can be effected through this means each plant will be sold by competitive bid.

Among the plants which will be offered for sale in the near future are the smokeless-powder plant at Charleston, W. Va., which cost the Government between $60,000,000 and $70,000,000. This plant, according to experts who are making appraisal, is adaptable for paper or chemical manufacturing. The picric-acid plant at Brunswick, Ga., which involved an expenditure of $6,000,000, will also be offered for sale shortly, as will also the picric-acid plant at Little Rock, Ark., which has only been in operation a short time. The picric-acid plants are said to be adaptable for use in manufacturing fertilizer.

The nitrate plant No. 4, at Cincinnati, Ohio, which was less than 50% completed, is also slated for early sale. This consists of completed steel buildings and structural steel on the ground.

W. G. Sloan, who served in France as a major in the 22nd Engineers, and who was formerly vice-president of McArthur Bros., contractors, of New York, is in charge of the disposal of plant facilities. He is assisted by B. L. G. Rees, formerly engineer executive of the McArthur company and who was a captain in the Engineer Corps during the war.

New York City To Build Piers on Staten Island

Fourteen new steamship piers on the east shore of Staten Island have been authorized by the Commissioners of the Sinking Fund of New York, this being the last step legally required before the Department of Docks may begin work. The piers are to be located just inside the Narrows, between Tompkinsville and Clifton. They will be each 125 ft. wide and will vary in length from 1000 to 1124 ft. and will be provided with one-story sheds. As at present designed, the piers are of the New York type; that is, with sheds occupying practically all of the pier so that freight handling has to be done from cargo masts. The total cost of the development will be about $15,000,000. Present titleholders of the property must vacate by September.

Commissioner Hulbert, of the Department of Docks, has also announced what is termed the "Hulbert Port Development Plan." This comprises the Staten Island development, the construction of the southerly five piers on the North River, reconstruction of scattered piers throughout the city, construction of three piers in South Brooklyn, an addition of one steamship pier to the present North River 48th St. group, "intensive study of the Jamaica Bay improvement," work for the straightening of the Harlem River, and study of the East River shores.

None of these projects can go forward without the financial aid which must be authorized by the Sinking Fund Commission, made up mainly of members of the city administration.

Buffalo Sells Its Garbage on Chicago Hog-Price Basis

After negotiations with several parties extending through several recent months, Buffalo has decided to let a five-year contract for garbage disposal by feeding to hogs. The contractor, Dr. T. B. Huff, offers to pay 50c. a ton as a minimum, with increases varying with (1) the price of live hogs on the Chicago market and (2) the quantity of separated garbage delivered yearly by the city. Regardless of yearly total, the contractor is to pay the city a price per ton of garbage six times the Chicago price of live hogs. If the yearly garbage total exceeds 30,000 tons, the multiple becomes seven, and if it exceeds 40,000 tons it will be eight. These multiples are to be based on average monthly prices and on corresponding monthly totals. The city agrees to employ two and, if need be, three inspectors; to carry on an education campaign for separation of garbage from other city refuse; to pass and enforce an ordinance prohibiting any collections except by the city; and to make daily deliveries to the feeding platforms, except on Sundays and holidays. The contractor agrees to be ready Oct. 1 to accept all garbage delivered by the city, and expects to accept some before that time. A tentative agreement has been made with the International Agricultural Corporation to continue to treat the garbage by reduction from the time of the expiration of its contract Aug. 1 until arrangements for feeding can be made, doing the work on the cost-plus basis. A Baltimore contract for garbage disposal by feeding, at a price per ton of 3½ times the Chicago market price for live hogs, was described in *Engineering News-Record* of Feb. 6, 1919 p. 287.

Contributions From Engineers, Architects and Constructors' Conference on National Public Works

M. O. LEIGHTON, Chairman

PUBLISHER'S NOTE: *The space occupied under this caption is donated to serve as a means of frequent and intimate communication between the Engineers, Architects and Constructors' Conference on National Public Works and the members of the profession. The contributor takes full authority for the statements made.*

National Chaos in Our Rivers—Do We Need a National Department of Public Works?

The rivers of our country are the nation's greatest industrial plant. They furnish transportation, power, irrigation and domestic water-supply. They perpetuate swamps, define natural and political boundaries, and furnish sites for parks and places of recreation. They are the receptacles for city sewage. They rise in flood and destroy lives and property, and to compensate for this they harbor fish which constitute a not insignificant portion of our food supply. They are essential to placer mining, to numerous industrial processes, to fire protection and to some kinds of engineering construction.

Rivers are rivers. They are a unit from source to mouth. They all run down hill, discharge the same water, and invoke the same hydraulic principles. Each problem that they present merges with every other, and there can be no final and satisfactory solution of one that does not defer to the requirements of every other. One may as well try to separate the functions of a hand or a foot from those of the remainder of the body. If there be any Government function that requires a single authority and sane, consistent and coördinated management, it is the function relating to rivers.

Water-power development is under:

(1) The Department of War; Corps of Engineers;
(2) the Department of the Interior;
  (a) the Geological Survey;
  (b) the General Land Office and, in certain cases,
  (c) the Reclamation Service;
  (d) the National Park Service;
  (e) the Bureau of Indian Affairs;
(3) the Department of Agriculture; the Forest Service.

If these rivers rise in flood:

(1) The warnings are sounded by the Department of Agriculture; the Weather Bureau;
(2) the amount of water is measured by the Department of the Interior; the Geological Survey in most cases and the Reclamation Service in others;
(3) and certain *ex post facto* observations and conclusions are delivered by the Department of War; the Corps of Engineers.

If these rivers are to be used for irrigation:

(1) Any public lands involved must be subject to the action of the Department of the Interior; the General Land Office; except,
(2) if any lands in the national forests are involved there must be approval of or interference by the Department of Agriculture; the Forest Service; or
(3) if any of the project occupies land in an Indian reservation there must be approval of or interference by the Department of the Interior; the Office of Indian Affairs;
(4) furthermore, if the project be one of the Government's own then it is presided over by the Department of the Interior; the Reclamation Service.
(5) and then the whole thing may be subject to the consent of the Department of War; the Corps of Engineers, under the guise of interference with navigation and whether there be any actual navigation or not.

If it becomes necessary to make a river survey, that work may fall to any one of the following:

(1) The Department of War; the Corps of Engineers;
(2) the Department of State; the International Joint Boundary Commission;
(3) the Department of Commerce; the Coast and Geodetic Survey;
(4) the Department of Agriculture;
  (a) the Bureau of Roads and Rural Engineering;
  (b) the Forest Service;
  (c) the Bureau of Soils;
  (d) the Weather Bureau;
(5) the Department of the Interior;
  (a) the Geological Survey;
  (b) the General Land Office;
  (c) the Reclamation Service;
  (d) the Bureau of Indian Affairs;
  (e) the National Park Service.

If questions arise as to wet and overflowed lands the following departments find points of entrance:

(1) The Department of Agriculture; the Bureau of Roads and Rural Engineering;
(2) the Department of the Interior;
  (a) the Reclamation Service;
  (b) the Geological Survey;
(3) the Department of War; the Corps of Engineers.

If an issue arises as to the deposit of sewage or other foreign matter, one or more of the following is concerned:

(1) The Department of the Treasury; the Bureau of the Public Health Service;
(2) the Department of War; the Corps of Engineers and the California Débris Commission;
(3) the Department of Agriculture; the Bureau of Public Roads and Rural Engineering; also the Forest Service;
(4) the Department of the Interior;
  (a) the Reclamation Service;
  (b) the Geological Survey;
  (c) the National Park Service;
(5) the Department of State; the International Joint Boundary Commission.

All of these departments operate independently. Instances of mutual working agreement are so rare as to cause comment. Each department has its own regulations and rules of procedure, its own ideas, specifications, methods and specific objects. The race for departmental supremacy is often more prominent than the object to be attained by the official activities.

Then, think of the overheads, the duplications, the cross-purposes, the multiple accounting and the technical and clerical help; also the duplicated property and equipment, the duplicated traveling expenses. Think of it all, you men who are accustomed to manage a business, and finally decide whether we need a Department of Public Works.

Law to Curb Motor-Vehicle Thefts

Trafficking in stolen motor vehicles is very stringently regulated by a law passed by the legislature of Pennsylvania and recently signed by Governor Sproul. A fine not exceeding $5,000 and imprisonment for a period of not less than 10 years are provided for motor thieves. Special transfers containing a full description and history of a vehicle must be given to purchasers with every used car.

The bill, which is known as the Cox bill, contains the following provisions:

1. That the person conveying title to any used motor vehicle must furnish to the buyer a full description of vehicle in duplicate, containing the name of the manufacturer, the horsepower, the number under which it was last registered by the State Highway Department of Pennsylvania or of another state, with a full account of the numbers and marks identifying the vehicle. Also a statement in duplicate giving the name or names and residences of the previous owner or owners, with information as to where they may be found.

2. The purchaser must insist upon receiving the above description in duplicate. He must then within 10 days make a duplicate statement, giving his name and the complete facts, and send it with the other duplicate statement to the State Highway Department. No license may be given out by the State Highway Department until the law is complied with.

Various other sections pertain to the State Highway Department keeping a record of violations of the provisions against changing the trademarks, the manufacturing number, or other distinguishing marks on any motor vehicle, and requiring proprietors of public garages to keep a record of the names of all persons owning or having charge of vehicles stored or left for repairs or other purposes at the public garage, together with the make, manufacturer's number, name of the state of registration and the registration number.

Food Committee Recommends Rural Motor Express

Transportation of foodstuffs by motor trucks is recommended to Governor Smith of New York by the committee on food production and distribution of the New York Reconstruction Commission. Rural motor-express systems, to be owned by coöperative associations similar to the Farmers' Coöperative Co. of Harford County, Maryland, are suggested.

In advocating the establishment of such systems throughout the state, the committee sets forth the inability of farmers to deliver perishable produce quickly to market. This condition, it was stated, made them reluctant to plant such produce and greatly holds down production. The great advantage of the motor express in taking foodstuffs directly from the farms to the cities, thus saving the time which the farmer loses in hauling, was also brought out.

That routes such as are advocated are successful was shown by the citing of several examples distributed throughout the country. Much greater speed of delivery by truck than by railroad over distances from 180 to 200 miles was shown by actual tests. One test described the loading at 6 a.m. at Lancaster, Penn., of 18,000 eggs in crates and 1000 day-old chicks, to be delivered in New York, 180 miles away. At the same time a similar shipment was made by train. The truck arrived at the door of the consignee in New York 12 hours after leaving Lancaster, with nine eggs broken and four chicks dead. The train shipment was four days in reaching Jersey City, another day was lost in sending notice to the consignee, whereupon he was obliged to send his own truck to get the shipment. When it finally reached his door several thousand eggs were broken and half the chicks were dead.

It was the opinion of the committee that the establishment of such routes would greatly decrease the cost of foodstuffs and also help to increase the supply.

Civil Service Examinations

United States

For United States civil service examinations, listed below, apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

Master computer, $2400 to $1800 per year, computer (Grade I) $1800 to $1400 and computer (Grade II) $1400 to $900, Ordnance Department. Applications will be received until further notice.

Electrical assistant, signal service at large, War Department, for duty at Manila, Philippine Islands, $1500 to $2000 per year. Applications must be filed before the close of business on Aug. 19.

Technical assistant, field of civil engineering, $3200 per year, and technical assistant, torpedo design, $3000 per year. Applications must be filed by Aug. 19.

Supervising draftsman, bureau of steam engineering, Navy Department, $12.80 to $13.60 per diem. Applications must be filed before August 19.

ENGINEERING SOCIETIES

Calendar

Annual Meeting

NEW ENGLAND WATER WORKS ASSOCIATION; Tremont Temple, Boston; Sept. 30, Oct. 1-3, Albany, N. Y.

The Southern California Association of Members of the American Society of Civil Engineers was addressed July 9 by C. E. Tait, senior irrigation engineer, Bureau of Public Roads, who read a paper on "Spreading as Related to Flood Control."

The Engineers' Club of San Francisco held a meeting July 10 at which Philip N. Moore, past president of the American Institute of Mining, and Metallurgical Engineers, spoke on the establishment of a national Department of Public Works.

The New York Chapter of the American Association of Engineers held a meeting July 23 at which Henry Stern, chief of the professional section of the United States Employment Service, and assistant Federal director, spoke on "Placing of Professional Men in Proper Positions."

The Charlotte, N. C., Chapter of the American Association of Engineers held its first regular meeting July 19. The following officers were elected: President, J. S. Lemond; vice-president, W. E. Vest; recording secretary, G. P. Ashbury; corresponding secretary, Alfred Greif; treasurer, Lacy Moore.

PERSONAL NOTES

L. L. HIDINGER, vice-president of the Morgan Engineering Co., Memphis, is now acting as chief engineer of the Little River Drainage District, Missouri, in addition to his other duties with the company.

C. J. WHITE, formerly resident engineer, Northern Pacific Ry., has resigned to become assistant highway engineer, State Highway Department of Minnesota, with headquarters at Pine River.

WALTER N. FRICKSTAD, engineer's office, Oakland, Calif., has been appointed a senior highway engineer, United States Bureau of Public Roads, with headquarters at Ogden, Utah.

LIEUT. COL. W. J. BARDEN, Corps of Engineers, U. S. A., has been appointed district engineer in charge of the United States Engineer's office at Jacksonville, Fla., succeeding MAJ. GLEN E. EDGERTON, Corps of Engineers. Colonel Barden recently returned from France, where he served as chief engineer, Ninth Corps of Engineers, with the rank of colonel.

CAPT. CHARLES CAULSON, Canadian Expeditionary Forces, has been appointed city engineer of Welland, Ont.

LIEUT. GERALD F. HEALEY, U. S. A., who was previously in the employ of the New York State Highway Department, has received his discharge from the service and has entered the Bureau of Public Roads, Washington, D. C.

FRED W. YOUNG and KENNETH T. YOUNG have become associated with their father under the firm name of CHARLES W. YOUNG AND SONS, of Boston, to engage in the management and operation of public utilities.

D. K. ORR, assistant chief engineer of the Monongahela R.R., has been appointed superintendent, with headquarters at Brownsville, Penn.

P. T. WILTSE, for the past year manager of the Doctor Shipbuilding & Drydock Co., Maury Island, Wash., has resumed his engineering practice in Seattle. He will continue his connection with the company.

LIEUT. COL. JOHN A. AMYOT, of Toronto, has been appointed deputy minister in the recently created Department of Health. Dr. Amyot served as sanitation officer with the Canadian Expeditionary Forces, and was made a Companion of the Order of St. Michael and St. George (C.M.G.). He is a graduate of St. Michael's College and the University of Toronto.

GEORGE H. WILLITS will not accept appointment as assistant county engineer of Dallas County, Texas, as noted in these columns July 3, p. 47. J. F. WITT resigned as county engineer, as noted in *Engineering News-Record* of June 26, p. 1285; Mr. Willits was to have been his assistant.

MAJ. FORREST S. HARVEY, Construction Division, U. S. A., assistant to the constructing quartermaster, Charleston port terminals, has been assigned as constructing quartermaster, Panama Canal Zone, with headquarters at Corozal.

MAJ. WILLIAM BOWIE, chief of the Division of Geodesy, United States Coast and Geodetic Survey, sailed recently for Brussels to attend a conference of the International Research Council, to be held July 18-Aug. 10.

DR. V. BUSH has been appointed associate professor of electrical engineering, Massachusetts Institute of

Technology. During the war Dr. Bush was associated with the researches of the United States Navy at New London for the detection of submarines.

CAPT. A. L. TRAUT, U. S. A., recently returned from France and will resume his engineering practice in Detroit.

C. F. KELLER, for the past 15 years assistant engineer, Department of Docks, New York City, has been appointed chief engineer succeeding C. W. STANIFORD, resigned.

MAJ. G. C. MUNOZ, Ordnance Department, U. S. A., has received his discharge from the service and has become associated with the American Pulley Co., Philadelphia.

BERNARD SNELL, Construction Division, U. S. A., has been relieved as engineer of railroads, Charleston port terminals, to become assistant to the constructing quartermaster, Corozal, C. Z.

CAPT. ADRIAN GROOT, 37th Engineers, A. E. F., has received his discharge from the service and will resume his work as head of the GROOT ENGINEERING CO., Rochester, N. Y.

COL. RALPH T. WARD, U. S. A., who recently returned from France, has been appointed district engineer in charge of improvements of the Missouri River.

O. J. EIDMAN, assistant bridge engineer, Kansas State Highway Commission, has resigned to become structural engineer, SOUTHWESTERN ENGINEERING CO., Hutchinson, Kan.

W. H. SCALES, previously with the Lackawanna Bridge Co., has become connected with W. E. Russ, architect, Indianapolis.

H. D. BRADSHAW, formerly of the United States Housing Corporation, has become associated with Wesley B. Porch, contractor, of Atlantic City, New Jersey.

OBITUARY

COL. JAMES KILBOURNE, president of the Kilbourne & Jacobs Mfg. Co., of Columbus, Ohio, died recently in that city. Colonel Kilbourne was known in the engineering field as the founder and builder of one of the largest contractors' equipment manufacturing plants in the Middle West. He was graduated from Kenyon Technical College, afterwards from Harvard, with the degree of LL.B., later receiving the degree of LL.D. from Kenyon College. After practicing law for a time he founded the company of which he was president and general manager at the time of his death.

GEORGE W. OAKES, head of the firm of George W. Oakes & Co., contractors, St. Paul, Minn., died in that city, July 16, at the age of 75. He was born in Ohio, and after serving in the Civil War went west, becoming one of the pioneer contractors of St. Paul. He had engaged in numerous railroad contracts and had built a large amount of the heavy foundation work done in the city.

HENRI VALENTA CARRERE, building contractor, New York City, died July 7. He had been successively associated with the Vreeland Contracting Co., the Schaeffer Construction Co. and Jacobs & Young.

New Device Indicates Proper Grade of Asphalt

A three-plate circular slide indicator for the proper grade of asphalt to use has been issued by the United States Asphalt Refining Co., of 90 West St., New York. Given the type of construction, the temperature range, and the degree of traffic, the device can be immediately set to show the grade number.

NEW ASPHALT INDICATOR SHOWS GRADE TO USE

The rings are made of celluloid, the entire instrument and its base being covered with this material. As set in the view herewith, it shows that with asphalt macadam (hot-mix), moderate temperatures and moderate traffic, grade No. 75 Aztec asphalt should be used. Instructions for the use of the instrument are given on the front, while on the back are given the various grade numbers with their range in penetration.

BUSINESS NOTES

THE SMITH-BOOTH-USHER CO., of Los Angeles, Calif., has opened offices at 433 Rialto Building, San Francisco. The company is the California, Nevada and Arizona agent for the following: Bessemer Gas Engine Co.; Foos Gas Engine Co.; Lakewood Engineering Co.; Clyde Iron Works; Barber-Greene Co.; Ohio Locomotive Crane Co.; J. D. Fate Co.; Cincinnati Iron & Steel Co.; Henry & Wright; C. & G. Cooper; Van Blerck Motor Co., and others.

THE WHEELER CONDENSER & ENGINEERING CO., of Carteret, N. J., has elected J. J. Brown, formerly vice-president and general manager, as president, succeeding Charles W. Wheeler, who died recently. H. S. Brown, of Boston, Mass., was elected vice-president. No other changes were made in the officers of the company at the recent election.

TRADE PUBLICATIONS

The following companies have issued trade publications:

THE SMITH ENGINEERING WORKS, manufacturers of rock, ore and gravel handling machinery, 32nd and Locust Streets, Milwaukee, Wis.; two catalogs, 7½ x 10¾ in., 15 pages and 35 pages, respectively; one describes gyratory crushing machinery, and the other mining, quarry and gravel pit machinery.

THE SPRAGUE ELECTRIC WORKS OF THE GENERAL ELECTRIC CO., of 527-531 W. 34th St., New York City; bulletin, 8 x 10½ in., 15 pages, illustrated; subject, the Sprague adjustable loop system of overhead material-handling machinery for terminal sheds.

THE MCGRAW-HILL BOOK CO., INC., 239 W. 39th St., New York City; booklet, 8¾ x 11½ in., 12 pages, illustrated; entitled "Ten Years," being a history of the development of the company.

THE SPRAY ENGINEERING CO., of 93 Federal St., Boston; catalog, 8 x 11 in., 16 pages, illustrated; describes air-washing and cooling equipment especially applicable for steam turbine generators.

THE WELLMAN-SEAVER-MORGAN CO., engineers and manufacturers, of East 70th St. and Central Ave., Cleveland, Ohio; folder, 8½ x 11 in., 4 pages; contains three charts for reading shaft diameters, torsional stress, speed in revolutions per minute, and power when the necessary factors are known.

THE MCLEOD CO., of Bogen St., Cincinnati; catalog, 6 x 9 in., 28 pages, illustrated; contains descriptions of labor-saving devices for the use of city engineers, superintendents of streets, paving contractors, water-works superintendents, etc.

THE MASSEY CONCRETE PRODUCTS CORPORATION, of the Peoples' Gas Building, Chicago; catalog, 4½ x 7¾ in., 23 pages, illustrated; gives general information on Massey factory-made reinforced-concrete products.